DISCOVERY

Monthly Notebook
DAVID S. EVANS, M.A., Ph.D., F.Inst.P.

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WILLIAM E. DICK

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M. DAVIDSON, D.Sc., F.R.A.S.

A Specialised Testing Laboratory

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Far and Near

VITAMINS: an impression from the film "World of Plenty" *Courtesy of Paul Rotha*

NOVEMBER

1/6

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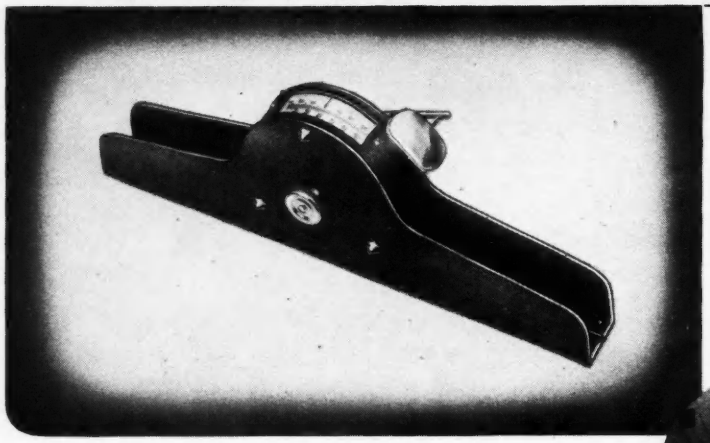

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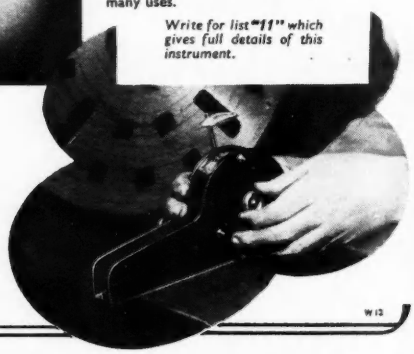

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DISCOVERY

THE MAGAZINE OF SCIENTIFIC PROGRESS

November 1943 Vol. IV No. 11 PUBLISHED AT THE EMPIRE PRESS, NORWICH, ENGLAND Tel. 21441

The Progress of Science

A MONTHLY NOTEBOOK COMPILED UNDER THE DIRECTION OF DAVID S. EVANS

"World of Plenty"

It may be possible to fool the people half the time, but to-day the British public is in no mood for fooling. It takes its war and its life seriously. Even in its entertainment it is demanding realism and ideas for serious discussion, for it knows that just as war is too serious a matter to be left to the generals, so peace is too serious to be left to the politicians. So it is that the best-sellers among the films are the non-fiction films, the informative documentaries, or the productions in which the love interest, the happy ending, are subordinate to the harsh realism of the times, and where burlesque relief finds hardly any place. The films that draw the crowds are of the calibre of "Mission to Moscow", "Target for To-night" and "Desert Victory". When Hollywood has tried to mix farce with war as in "Cargo of Innocents" or "Mademoiselle France", it has jarred its public with a sense of unreality. Even "Casablanca"—the story of a girl who escaped from the Nazis with eight evening frocks —was successful only because its other merits outweighed the incongruities. However, as our American friends get deeper into the war the tinsel is being stripped away, as a picture such as "Action in the North Atlantic" shows.

Among the names of those in this country who have made outstanding films of the realistic type now being demanded, there are few more honoured than that of Mr. Paul Rotha. Scientists already know his documentaries well and have been full of praise for his technical films, such as the one dealing with the blood transfusion service. Now Mr. Rotha and his associates have made a scientific film which the general public ought to see, and which can be confidently backed as a best-seller. The accompanying "stills" of this film are reproduced through his courtesy.

"World of Plenty" is a film about food. It describes food as it was in the days of depression—the story of want and poverty and of food desperately needed being destroyed or fed to animals. It describes food as it is—increased output from British farms; Lease-Lend which has saved the life of Britain; rationing. It describes, through the mouths of technical experts such as Sir John Orr and Sir John Russell, food as it might be.

What is so new in all this? Have we not become so hardened to this strange story that we accept it with only half our attention? Who can make a film that is full of excitement and deep emotional interest out of tables of statistics? Mr. Rotha aided by Dr. Neurath of the Isotype Institute has done it. Look behind those tables of statistics which we quote so easily and see what they mean, not to an abstraction such as the "community" or the "general public", but in real human terms. The merit of this film is that it is a technical masterpiece which puts figures of crops and output into direct relation with visible human beings, people who might be our own next-door neighbours or the man we met in the local.

It opens as if it were going to be a straight narrative. The shots of rolling fields, of harvests and tractors begin to appear as in so many other documentaries. The little figures of men and cows, and heads of grain each representing so many million workers, so many thousand cattle, and so many bushels pop into their places on the screen. Suddenly a voice says, "Wait a moment, I want to see that again." Almost instinctively one turns in one's seat to see who asked the question. It might have been your own voice asking for the explanation of a difficult point, but it is the film itself asking the questions you want to ask.

The film is not an exposition but a discussion, with a disembodied voice which asks just the right questions at precisely the correct moments. Each disputant has all the resources of the cinema at his disposal, and both the narrator and the devil's advocate call up sequences and personalities as they wish. But technique is not everything. It is the spirit of the makers that counts. They have made a dangerous film, dangerous to complacency and inaction; a film in which we ourselves are the heroes, and in which the villain is the evil suffering which must not recur after the war. "But this," says the voice "is revolutionary"; and "What", says Sir John Orr, bending his kind eyes beneath their beetling brows on the audience, "are we fighting this war for if not for something revolutionary?"

Sir John Orr, the dietician, who plays a leading role in the film

Milk for all school children in Britain is a war experiment

This is a film which re-affirms the belief in democracy, and for which praise must go, not only to Mr. Rotha and Dr. Neurath, but to the Ministry of Information which has shown a slightly unexpected breadth of vision in sponsoring it; to the Minister of Food and the other distinguished men who speak part of the story; and to other great names such as those of Mr. Vice-President Wallace and Dr. Wellington Koo, parts of whose recorded speeches on several occasions are included.

There is a postscript to this film written recently in London. The occasion was a conference on post-war rehabilitation in Europe organised by the Association of Scientific Workers. There, scientists, representatives of relief organisations, trade unionists, and men escaped from occupied countries discussed the practical measures necessary for bringing plenty to Europe after the war. Here too, the problem was stated in human terms, partly in terms of what a man must have to keep his soul and body together, partly in statistics of the pitiful rations that the subjugated nations are actually getting, and partly in the description—almost too painful to listen to—of conditions of life in occupied Europe, given by those who had suffered themselves. To them, Nazi aggression means much more than blackout, shopping difficulties, rationing, and housing shortage. It is the blood, sweat and tears of all pervading tyranny: ceaseless anxiety for friends and family, real hunger and real defencelessness from the weather.

The conference was realistic. It left no doubt in the mind of anyone that in order to fulfil our inalienable obligation to those who are fighting and suffering on our behalf with all the odds against them, we ourselves must face sacrifices. We must be prepared to face continued rationing for some time after the war, probably more severe than that which obtains to-day, if the nations of Europe which have gone underground in the fight are to have no more than the barest essentials of life. The implementation of the Atlantic Charter will mean the acceptance of self-denial by each man and woman not only here but in the United States and the other United Nations.

Each individual must realise in his own heart—and his own stomach too if necessary—that the world of plenty must be paid for and fought for if it is to be achieved. It can only be achieved if the whole human race feels a common solidarity, and rates the suffering of a million Chinese or Indians on the same level as it would rate the suffering of an equal number of its own people. "World" is as important as "Plenty", for plenty can never be permanent if it is the monopoly of one section of the human race.

Fruit juices and oils for mothers and children

Miners need special kinds of food

A Matter of Principle

GENERAL LANE FOX PITT-RIVERS introduced a new technique into the analysis and exhibition of anthropological specimens when he arranged his collection of weapons in the order corresponding to their evolution of function. This type of arrangement gave a new insight into the significance of features of human handiwork which had hitherto appeared meaningless. We might gain an equal insight into the ways in which scientific knowledge comes into application if we were to study them, not by the larger disciplines in which the applications are made, but by correlating the applications of the same principle in different connections.

If we were to do this, we should find few principles which have found more diverse application than that of diathermic heating, that is, the heating of non-conducting substances not by the application of heat to the exterior but by heating throughout the substance by the energy losses which occur when such a substance is placed in a rapidly alternating electric field at radio frequencies.

In its medical applications it has been used for the cure of venereal disease by raising the temperature of the body of the patient to such a level that the very delicate organisms responsible can no longer survive. In the operating theatre it has been employed as a cautery, the energy losses in the neighbourhood of the electric knife being sufficient to seal off the blood vessels as the incision is made.

In industry it has received a great variety of applications, one of the earliest being to dry tobacco without removing it from the hogsheads. Another application has been to the killing of insect pests in grain, since it has been found that the insects absorb more energy than the cereals, and hence become rapidly cooked. In the manufacture of plywood the same method has been used to make the glue set rapidly.

Lately the method has found its way into the plastics industry, where its property of producing uniform heating throughout a mass of material has been used for the production of thick plastic sections, which are otherwise costly and difficult to make.

Perhaps the neatest example of all is the electronic sewing machine developed by the Radio Corporation of America. Sheets of thermoplastic material such as synthetic rubber can be rapidly joined together by its aid. The material is fed between two small rollers between which a concentrated radio-frequency beam is passing and a long narrow welded seam is produced. The American Celanese Corporation have announced a similar process for welding fabrics together, and a technique based on the same principle has also been developed for metals.

In this latter case the heating produced by the alternating current is so large that the metal is melted locally and a spot-weld is produced. Methods of spot-welding have, of course, been in use for a long time, but this new technique has the advantage of much greater rapidity, and can produce up 1800 spot-welds (or "stitches") in a minute. In other cases the water-cooled copper jaws between which the current flows are replaced by copper wheels which produce a continuous seam.

Courtesy of the Radio Corporation of America

Experimental model of the RCA electrical sewing machine. Dimensions : 30" long, 20" wide, 36" high.

We are frequently assured that applications of electronics are likely to revolutionise our lives in the future, and there can be little doubt that this is so in the light of the variety of applications which this single principle has found. To the scientist this story will be more impressive as a demonstration of the universal applicability of scientific knowledge, and as a reminder that it is often possible to turn to good account an effect which is a nuisance in other connections. In this case the heating due to dielectric losses which is a nuisance in condensers has been turned to good use in a very large number of applications, and there can be little doubt that still more remain to be made.

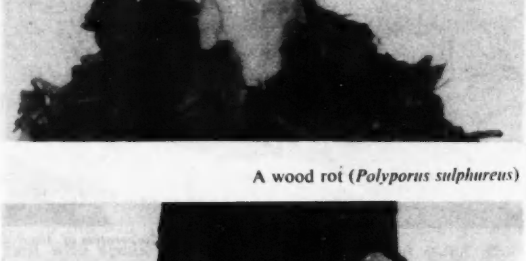
The Prophet at Home

IN the September issue of DISCOVERY was included an item entitled "Spot Light on Museum Technique" which referred to criticisms which had been made of some museums in this country. The last public occasion for such criticism which comes to mind was the conference of the British Association on "Science and the Citizen", when one speaker contrasted the empty tomb-like atmosphere of most museums in this country with the lively interest displayed in such leading institutions as the Buffalo Museum of Science in New York State, where it is not uncommon to see a notice "Museum Full" and a queue outside.

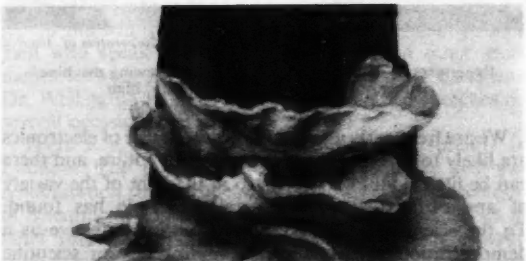
Part of this success is due to the realisation of the important part which a museum can play in explaining to the public their own surroundings and social system, and partly to the skilled use of media of presentation, such as models and vivid demonstrations of the kind shown in our series of photographs.

A correspondent writing from the National Museum of Wales has reminded us that we have our own progressive

Death cap (*Amanita phalloides*)



A wood rot (*Polyporus sulphureus*)



Boletus chrysenteron

museums in this country. Many of our readers will be familiar with the fascinating possibilities of an afternoon in the science museum at South Kensington, with its array of working models which respond to the touch of a button; on the same high standard is the folk museum at Norwich with its series of house interiors at various epochs, all so well arranged that one expects the householder to appear attired in the costume of the period, and looking completely natural in it as well. The National Museum of Wales is also to be listed among the exceptions, and it has matched the beauty of its architecture with a brilliance of technique in the construction of its exhibits.

Among these is a series of models of fungi which are designed to show not only the botanical details of the organism and the habitat in which it is to be found, but also, since the visible parts of fungi are most often those concerned in reproduction, the mechanism for dispersing the reproductive spores.

This collection of models has been built up over the course of a number of years, and scrupulous care has been taken to render them true representations of the original. The first step in making a model is to make an accurate water colour sketch. Then a cast either in plaster or Negocoll is made, and a wax positive constructed, using the cast as a mould. Alternatively, in the case of fungi which grow in the form of flat brackets, wax sheets are prepared by skimming blotting paper over the surface of suitably coloured wax in the molten condition. Such large brackets often have to be mechanically strengthened by giving them a backing with a sheet of waxed silk, and by using pins as supports.

Most of the models are mounted on peat blocks, the adhesives used being impregnated with poison to prevent the growth of mould, and they are surrounded with dead leaves, pine needles or other vegetation appropriate to the habitat. In the case of an exhibit of dry rot, an actual plank attacked by the fungus was used, the real fungus being removed, and being replaced on the plank (now thoroughly dried and treated with corrosive sublimate) by the model structure.

The finishing of the models was done with a knife or a hogs hair brush, the surfaces of the casts being smoothed where necessary with xylene. Any additional colour not included in the body of the wax was put on with paint, an aerograph (spray-painting) pen being sometimes used. If the surface should have a powdered appearance this was achieved by spraying with arrowroot. Some of these models made by Miss Eveline A. Jenkins, B.Sc., are shown in the photographs.

To Smoke or not to Smoke

THERE are few subjects more productive of argument, usually without any factual basis, than the effect on health of smoking and drinking. The ardent advocate of temperance condemns alcohol as a slow and deadly poison. The man who likes his drink, if ever he feels the need to justify himself, and he happens to have the figures available, quotes the case of the slightly increased longevity of a group of moderate drinkers which was found by one statistician. If the dispute is being conducted on a high intellectual plane the reply is an attack on the statistics. If not, it is usually a request to have another one, and a

change in subject. The same sort of argument prevails in the case of smoking, and we rejoice that we are able to give everyone a feeling of justification by the production of some completely inconclusive information.

There can be little doubt that smoking does produce physiological changes. Nicotine, absorbed by the smoker in minute quantity, is a powerful drug, which when injected into animals causes contraction of the blood vessels. Although the smoker absorbs only a minute quantity it is sufficient to be detectable in the urine, and it may be the effect of this drug in retarding the contractions of the stomach which are responsible for the alleged fact that smoking a cigarette postpones the feeling of hunger. On the other hand, some people claim that a morning cigarette acts as a laxative, and there does seem to be some evidence that smoking increases the activity of the colon.

One interesting fact is that many of the effects of nicotine are similar to those obtained by the injection of adrenaline, a hormone from the adrenal gland. It has in fact been suggested that nicotine operates by stimulating the liberation of adrenalin, so that the effects would be largely indirect. The effects of adrenalin are the production of a rise in the rate at which the pulse beats, a fall in the temperature of the skin, and a rise in the quantity of sugar in the blood. The latter effect may be the reason why a cigarette produces a feeling of "lift" in a tired subject.

It has also been stated that cigarette smoking renders one less able to resist the effects of oxygen lack, which might be a serious matter for high altitude flyers.

As far as experimental evidence goes there is little help to be gained. Two scientists in America found that smoking ten cigarettes per day caused a considerable rise in blood pressure in some subjects, but in others this did not occur. Three patients with gastric ulcers vomited and fainted after smoking three cigarettes on an empty stomach. Smoking certainly increases the flow of saliva, but as far as the secretion of gastric juice is concerned, the same indefiniteness prevails. In some people smoking produces an increase, but these are very few, and in most it is decreased or remains unchanged.

The upshot seems to be that as far as scientific evidence goes each one of us can continue to smoke as much or as little as he feels suits his own constitution. However, joking apart, it does seem that in view of the vast quantities of tobacco smoke which the human race inhales in these days, a little investigation uncontaminated by commercial interest would be well worth undertaking into the physical and psychological effects of tobacco smoke.

Immersion Foot

We are assured that the U-boat menace is being checked and presumably this means that the rate of sinking has been reduced. We also hear much of the gallant life-saving work carried out by Air-Sea Rescue in saving pilots whose kites have been ditched in the drink. Nevertheless, until the war ends—and even after—there will be men who have undergone dreadful hardship and suffering through being adrift in all kinds of weather, sometimes for days on end, paddling helplessly on rafts or rubber dinghies on the bitter surface of the ocean.

One result which often afflicts the survivors of such experiences is a painful swelling of the feet and lower legs which is known as "Immersion Foot". The cause is prolonged chilling short of actual freezing, which causes injury to the blood vessels and nerves. When the man is rescued and kept warm there is an increased flow of blood in the main vessels, but as the result of the damage already done, there is a lack of oxygen supply to the capillary bed of the skin. There is an increase in the permeability of the capillaries, the feet become swollen and painful and congested, and small pin-points of bleeding can be seen beneath the surface.

From an American source comes a report of the method of treatment to be employed for these cases. Contrary to what might be thought desirable, the remedy is to cool the affected feet and legs, the object being to reduce their metabolic rate, and so to bring down their demand for oxygen to the level at which it can be met by the damaged system. At the same time efforts should be made to prevent infection of the blisters which have formed, which might open the way to gangrene.

The suggestions which are made are first, that if time allows before abandoning ship all crews should put on their most loosely fitting and waterproof boots, and take along extra pairs of socks. Greasing the skin will also help to ward off frostbite of the hands and feet. However, it is obvious that in many cases such instructions are counsels of perfection, and that what must be done is to try to remedy the damage once it has occurred. The treatment recommended after rescue is that the feet should be cleaned with soap and cool water, and that blisters which have burst should be dusted with sulphanilamide powder or covered with sulphathiazole ointment.

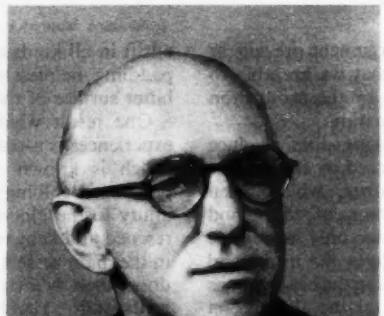
In hospital the feet should be kept cool by exposing them to the air of the room, being uncovered by bedclothes and exposed to air from a blower or electric fan. The object is to cool the skin to a temperature below 85°F. During the most intense stages of hot congested feet and severe neuritic pain, ice-packs have been used, but their application needs very considerable care, since if the feet are chilled or wetted by a leaky pack conditions similar to those that did the original damage may be produced.

It is reported that during recovery neuritic pain makes its appearance as nerve function is restored, but that this has disappeared within two weeks in mild cases. In severe cases it has been observed to be troublesome for six months. In general it is claimed that the majority of patients respond well to this form of treatment within a month or six weeks.

It is in cases such as this that the ordinary man realises how closely science can touch his life, and in Britain there will be gratitude for help from across the Atlantic on behalf of the devoted members of both nations who keep that life-line open at the cost of their own lives or of the severest physical suffering.

Immersion Foot: *American Bulletin of War Information*, Medical Letter No. 16, reporting James C. White, *New England Journal of Medicine*, February 18, 1943.

The Prophet at Home: *The Museum's Journal*, Vol. 38, May 1938.



Professor E. J. Salisbury, F.R.S.

DIRECTOR OF THE ROYAL BOTANIC GARDENS

KEW GARDENS became public property in 1840. It has been the nation's good fortune that the development of the gardens, now universally considered the finest in the world, has been entrusted to the care of such men as Sir William Hooker and his son Sir Joseph Hooker, Sir William Thiselton-Dyer, Sir David Prain and Sir Arthur Hill. In Professor E. J. Salisbury we have a worthy successor to this line of great directors, for he has that quality of intense interest in all branches of botanical science which has come to be regarded as the *sine qua non* when considering the directorship of Kew.

Born at Limbrick Hall, Harpenden, in April 1886, Edward James was the youngest of the five sons of Mr. J. Wright Salisbury, a business man and a director of several public companies.

In his youth Salisbury was always interested in flowers and used to spend much time walking and cycling through the Hertfordshire countryside with a packet of sandwiches in one pocket and a copy of Hooker's *Student's Flora* in the other. But it was not until he became an undergraduate at University College that he received any formal botanical training. In his choice of botany as a career the motive of cussedness played a not inconsiderable part. While he was at University College School, where he was educated before going to the university, he was asked by a master what he would like to be when he grew up, and with mock seriousness he said, "A botanist, sir," though he had never really given the subject much thought. The master waxed very sarcastic at the boy's expense, but his undisguised contempt for botany and botanists only had the effect of more firmly fixing this ambition, then only half-formed, in the boy's mind.

At the university he came under the tuition of that grand old man of British botany, Professor F. W. Oliver, who now lives—aged 79—near Alexandria. At the time Salisbury was starting his degree course, Professor Oliver was one of the leading authorities on fossil plants. Palæobotany was then a subject of fascinating difficulty, and not unnaturally Salisbury, on graduation, was attracted to its study. He developed a great liking for it, and his doctorate thesis was concerned with the seed of the fossil pteridosperm known as *Trigonocarpus shorensis*.

This period at University College gave Salisbury the advantage of working in a school of ecology that is best described as being in advance of its time, for Oliver was one of the first to realise the essentially dynamic character of vegetation and the implications of the concept that one type of plant community has no permanent claim upon a particular locality, but is liable to suffer infiltration and succession by a different assemblage of plants. Oliver's ecological studies were mainly associated with sand-dunes and salt marshes. His conducted tours of the marshes of Erqui evoked the famous rhyme :

> A certain professor of botany
> To save his class from monotony
> Led his students a dance
> Round a salt marsh in France
> To develop their brains—if they'd got any.

After gaining his degree Salisbury held the Quain Studentship of the college for four years, during which time he coupled research with a certain amount of teaching. Incidentally his first experience of lecturing was won in a hard school—the veterinary college at Camden Town. I gather that the embryo horse doctors who formed his first class had an even lower opinion of botany than did the master at U.C.S., but having once succeeded in overcoming their natural repugnance to the effeminate study of plants Salisbury never again found any difficulty in handling students in bulk !

Fritsch and Salisbury

In 1914 he went to East London College (now Queen Mary's College) as senior botany lecturer. It was during his term there that the successful firm of "Fritsch and Salisbury" was established. Salisbury was approached by a publisher who wanted him to write a textbook. He had some doubts about undertaking such a task on his own, and therefore approached the head of his department, Professor Fritsch, with the suggestion that they should collaborate. A rather unusual proposition for a professor to receive from a man who was his junior both in years and position, but Fritsch immediately agreed to come in, and the result was the first of the five textbooks written under their joint authorship—the *Introduction to the Study of Plants*, upon which so many botanical students have been reared.

Salisbury returned to University College at the end of the last war. Six years later he was appointed university reader in plant ecology, and in 1929 became Quain Professor. During the last war he became actively associated with the British Ecological Society. The larval form of this organisation was known as the British Vegetation Committee, and before its metamorphosis in 1913 it carried out very valuable pioneer work, producing detailed descriptions of plant communities all over the British Isles, one of its major achievements being the publication of *Types of British Vegetation*. The society's first secretary was the late Dr. Frank Cavers, who was also responsible for editing the *Journal of Ecology*. In 1917 Salisbury took over the secretaryship, which he did not relinquish until 1932.

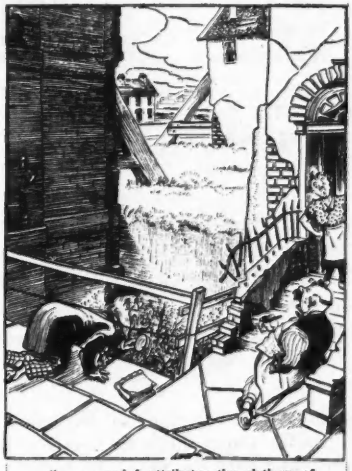
During the whole of that time Salisbury was adding steadily and considerably to our knowledge of British vegetation. The plant communities to which he gave the closest attention were the oak-hornbeam woods of Hertfordshire and the maritime associations to be found at Blakeney Point, Norfolk. His papers on these subjects —the ones on Blakeney were written jointly with Oliver —were published in the *Journal of Ecology* and are classics of their kind.

Doyen of Ecologists

His ecological work has developed along several distinct though closely correlated lines. One direction led him to the examination of the chemical and physical nature of different soils, soil character being an important factor determining what type of plant community can colonise a particular piece of ground. Another important line brings us to his most recent book, *The Reproductive Capacity of Plants*. There is no room here to quote extensively from this book, which presents a formidable array of facts in support of the author's hypothesis that the reproductive capacity of a species is as much a characteristic as any other specific feature "and moreover of the greatest ecological importance."

Ecology may well be called "modern natural history", and it is pleasing to find that Salisbury, like many other ecologists, is an enthusiastic supporter of natural history societies. To me he has acknowledged that his association with the Hertfordshire society provided him with much useful experience that helped to widen both his scientific knowledge and his interests outside botany. For several years he was hon. secretary of that society, and he is still one of its vice-presidents. He is an ex-president, too, of the Norfolk society, with which he came into contact through his Blakeney Point studies, and the president of the School Nature Study Union.

His most recent ecological observations have concerned the flora of bombed areas. His lecture to the Royal Institution on this subject aroused considerable interest, particularly among Fleet Street reporters who never tire of ringing him up to ask whether the London Rocket—its popular name derives from the manner in which it flared up in London after the Great Fire of 1666—has turned up again! His remarks about the rose-bay willow-herb which apparently thrives on soil that has been burnt led to a cartoon in the London *Evening News* which is reproduced here by courtesy of the editor.



". . . . and I attributes the plethora of Epilobium Angustifolium to the top-dressing of incendiaries in the autumn of '40."

Another investigation of Salisbury's that tickled the public fancy was the collection of seeds that he took out of trouser turn-ups. In this little exercise he enjoyed the co-operation of numerous friends, who soon became accustomed to his unusual request for samples of debris from their "trouser cuffs". These samples, sown on sterilised soil, sometimes yielded only a few plants, but in other instances were found to contain several hundreds of seeds.

He has two hobbies—walking and gardening. In his garden at Radlett, he has specialised in growing some of the rarer species of British wild plants so that he can study them during the seasons when he is unable to visit their native haunts. Combining his professional knowledge with his enthusiasm for gardening, he wrote *The Living Garden*, which revealed a talent for the popular exposition of scientific matters. I hope that during his term of office at Kew he will make good use of that talent, for I feel sure that a series of booklets about the plants that grow in the Royal Botanic Gardens would be welcomed by the public, who for so long have had to be content with a rather dreary guide-book and some coloured picture postcards.

WILLIAM E. DICK

The Night Sky in December

M. DAVIDSON, D.Sc., F.R.A.S.

The Moon.—Full moon occurs on December 11d. 16h. 24m. U.T. and new moon on December 27d. 15h. 23m. The following conjunctions take place:

Dec.				
11d. 00h.	Mars in conjunction with the moon		Mars	7 ° N.
12d. 01h.	Saturn	„ „	Saturn	2 N.
17d. 07h.	Jupiter	„ „	Jupiter	0·8 S.
23d. 19h.	Venus	„ „	Venus	3 S.
18d. 13h.	Mercury	„ „	Mercury	2 S.

Occultations.—The following occultations of stars brighter than magnitude 6 take place, the times referring to Greenwich:

			a	*b*
Dec.	4d. 18h. 09·5m. ψ' Aqr	D	−1·7m.	+0·1m.
	13d. 00h. 51·4m. ν Gem	D	−1·6m.	+1·2m.
	13d. 02h. 05·3m. ν Gem	R	−1·5m.	−1·5m.
	24d. 06h. 19·2m. γ Lib	D	−1·1m.	+1·6m.

(D and R refer to disappearance and reappearance, respectively).

The Planets.—At the beginning of the month Mercury sets 20 minutes after sunset and at the middle of the month about an hour later than the sun. The planet attains its greatest easterly elongation on December 23 and is stationary on December 30. On the latter date it sets about 17h. 15m. Venus is a morning star and rises at 3h. 22m., 3h. 53m. and 4h. 34m. at the beginning, middle and end of the month, respectively. Mars is an evening star and sets at 8h. 36m. at the beginning of the month. The planet is in opposition on December 5. At the middle and end of the month the times of setting are 7h. 11m. and 5h. 49m. respectively. On December 1 Mars is 50 million miles from the earth and this distance increases to 61 million miles on December 31. Jupiter rises at 22h. 11m., 21h. 17m., and 20h. 12m. at the beginning, middle and end of the month, respectively. The distance of the planet from the earth decreases from 470 million miles at the beginning of December to 431 million miles at the end of the month. Saturn, an evening star, sets at 9h., 7h. 56m., and 6h. 48m. at the beginning, middle and end of the month respectively. The planet is 750 million miles from the earth on December 1 and 2 million miles farther off on December 31. On December 16 a closer approach is made than on either of the above dates, the distance being 749 million miles; the planet is then in opposition. In addition to the above phenomena, Jupiter will be occulted by the moon on December 17d. 07h. 18·6m., reappearing 56·3 minutes later.

Winter Solstice occurs on December 22d, 17h., the sun then reaching his greatest southern declination.

Times of rising and setting of the sun and moon are given below, the latitude of Greenwich being assumed:

Dec.	Sunrise	Sunset	Moonrise	Moonset
1	7h. 42m.	15h. 55m.	11h. 13m.	20h. 04m.
15	7h. 59m.	15h. 50m.	19h. 37m.	10h. 37m.
31	8h. 06m.	15h. 59m.	11h. 04m.	21h. 41m.

Orion, the finest constellation in the heavens, contains many objects of telescopic interest. The Great Nebula in Orion, visible to the naked eye, surrounds θ Orionis which is the middle star of the sword of Orion. The haziness around θ is easily seen with the aid of binoculars to be a cloud of misty light, and with increasing optical aid this haziness becomes a cloud-like object increasing in size as greater power is employed. The luminosity of the diffuse nebulae, of which the Orion nebula is a type, is due to the influence of one or more stars lighting up diffuse dark matter in space. Not only is the light from a few stars reflected by the diffuse matter; it seems certain that hot stars are able to excite some of the gases in these nebulae to glow. The distance of the Great Nebula in Orion from us is about 600 light-years a small distance when compared with that of even the nearest of the spiral nebulae. α Orionis (generally known by its Arabic name Betelgeux) shines with a red light and is an irregular variable. It is a very large star, its diameter being more than 300 times that of the sun, but its density is very low. Its distance from us is about 200 light-years, so it is much closer to us than the Great Nebula in Orion. β Orionis, generally known as Rigel, has a companion of magnitude 9 at a distance of about 9″. Rigel is nearly 600 light-years away from us and is an intensely hot star, its surface temperature being about 24,000°C., which is four times as hot as our sun. Another double star is δ Orionis, its companion being magnitude 7 and its distance 53″ from δ. This companion is an easy object for a small telescope. Just under ζ Orionis, which is the lowest star in the belt, is σ which consists of two-multiple star. Two of these, magnitudes 6·3 and 7, can be seen with a small telescope. ζ Orionis is a beautiful double, its companion being 5·7 mag., but it is only 2·6″ from ζ and hence cannot be seen with a small telescope. There is another star in the same field at a distance 57″ and mag. 9, which affords an easy object for a 3-inch telescope.

The Geminid meteors are active from December 1—12, and emanate from different radiants in the constellation of Gemini. The meteors have usually short paths.

A nova has been discovered in Aquila and its magnitude at the beginning of October was a little brighter than 12. Those who have an equatorial mount will find it in R.A. 19h. 45·5m., Dec. + 8° 06′. It has been observed with a 3-inch refractor.

FIG. 1.—General view of the electrical testing laboratory at Messrs. Turners Asbestos Cement Co., Ltd.

A Specialised Testing Laboratory

THE man in the street is now familiar with the idea that Research will provide a solution for the material problems of both the war and post-war world. The demand will be such as to entail ever more research facilities and larger numbers of investigators with the appropriate training. The installation sketched in brief outline in this article is symptomatic of the specialised planning and equipping for research now so urgently needed and is a tribute to the enterprising foresight of the company concerned.

The Turners Asbestos Cement Co. Ltd. of Trafford Park, Manchester, are well known as suppliers of certain kinds of insulation materials requiring consistently exact electrical properties. Foreseeing possibilities of considerable development in their specialities, that company decided to embark on a policy of extensive research on such a scale as to involve a completely new research department. The result has been the creation of a comprehensive series of experimenting laboratories that are representative of modern industry at its best. Included in these laboratories is a high tension and insulation testing laboratory forming the subject of this notice.

The electrical testing laboratory which was designed, equipped, installed throughout for Messrs. Turners by Metropolitan-Vickers is seen in Fig. 1, the high tension section being seen at the far end through an interlocking wicket-gate.

High voltage a.c. up to 105 kV. is provided by three

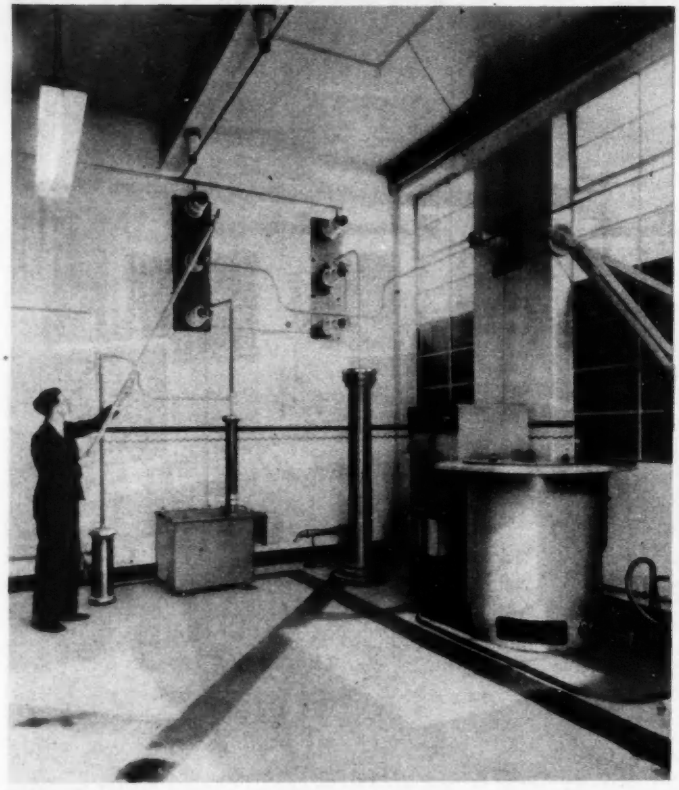


FIG. 2.—The 105 kV. transformer in square tank with crest voltmeter on left, compressed air condenser, oil tank and its control on right.

transformers designed respectively for 105 kV., 35 kV. and 6·6 kV., and d.c. supply up to 50 kV. plus or minus is available from a special d.c. set. The 105 kV. transformer rated at 5·3 kVA. continuous is oil-immersed in the square tank seen in Fig. 2. It is of special design with cross-over wound waxed coils similar to transformers used in X-ray equipments. The 35 kV. transformer is seen in Fig. 3 with the d.c. set on the left, and is similar in design to the 105 kV. transformer: the 6·6 kV. transformer is obscured in the photograph by the 35 kV. unit. The d.c. set, which is fed from the 35 kV. transformer, consists of a filament transformer with a thermionic rectifier mounted on it.

Control and Distribution

The 105 kV. unit is controlled from the desk next to the gate (Fig. 1) by a "Variac" auto-transformer giving smooth regulation from zero to 105 kV.; the voltage is measured by a "crest" voltmeter, the condenser for which can be seen on the extreme left in Fig. 2. The desk under the testing cage in Fig. 1 controls similarly the 35 kV. or the 6·6 kV. transformer, only one of these being in use at a time; the crest voltmeter condenser in this case is mounted on the 35 kV. transformer as depicted in Fig. 3. The 50 kV. d.c. set is supplied from the 35 kV. transformer by suitable change-over connections.

The distribution arrangements are of interest as representing one aspect of the flexibility required. There are two systems of solid drawn brass tubing busbars running overhead round the wall of the high-tension chamber as already seen in Figs. 1 and 3 and fitted with change-over switches, one of which is being manipulated in Fig. 2. One of these busbar systems is insulated for 105 kV. and the other for 35 kV.; the former can be connected to any of the three transformers while the latter is so arranged that the 105 kV. transformer cannot be switched on to it. Both busbars can be in use simultaneously on independent voltages. The 35 kV. busbar is extended beyond the high-tension chamber for the other services but the 105 kV. supply cannot be brought out of the H.T. area. The four cubicles seen on the left of the laboratory in Fig. 1 are ovens, the purpose of which will be discussed later. The remaining items of equipment of note are the sphere gap, the oil tank, the Schering bridge, the testing cage, the insulation resistivity tester and the surface leaking tester.

Tests to be Carried Out

The main tests to be carried out comprise:

(*a*) H.V. breakdown tests in air or in oil, hot or cold.
(*b*) Power loss factor tests.

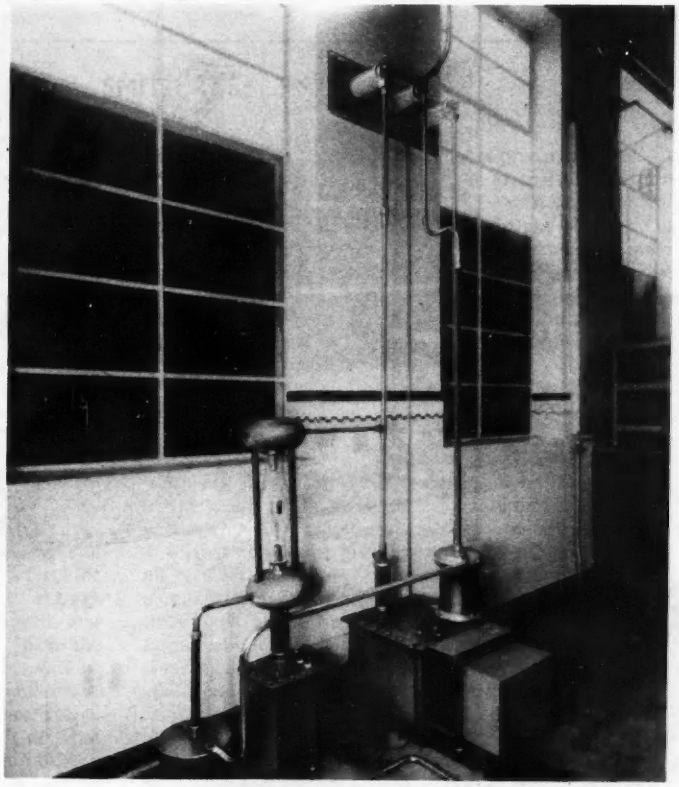


FIG. 3.—The 50 kV. d.c. set on left and 35 kV. transformer on right.

(*c*) Resistivity tests, surface and volume.
(*d*) Surface leakage tests.

In tests (*a*) an increasing voltage is applied across a specified thickness of material and either an instructive breakdown occurs or the material can be certified for the voltage used.

The specimen under test may be considered as an imperfect condenser in which the current leads the applied voltage by an angle which is less than 90° by an amount known as the "loss angle". The tangent of this loss angle (Tan 8) is obtained from bridge readings and for all practical purposes may be taken as being equal to the power factor of the specimen. The capacitance of the specimen is also obtained directly from bridge readings and the product of the specimen's capacitance and thickness is proportional to its permittivity. The power loss factor is defined as the product of power factor and permittivity.

Since many of the dielectrics handled in that laboratory are for use in connection with radio engineering an audio-frequency Schering bridge is required in addition to the bridge for the standard 50-cycle frequency. Expressed in a simple analogy the Schering bridge is a Wheatstone bridge in which two of the resistance arms are replaced by condensers and one of them is paralleled by a condenser. The 50-cycle frequency bridge box is contained in the centre desk of Fig. 1 and can be used with specimens stressed at any voltage up to 105 kV. The standard condenser is shown in the centre of Fig. 2 and is of the compressed air pattern. The special electrode for holding the test piece is seen in the cage in Fig. 1. The audio-frequency set is placed on the bench in Fig. 4 in its three elements : test electrodes, measuring box and oscillator.

The dielectrics are often required to withstand tropical heat and humidity and tests have therefore to be made under such conditions. For this purpose there are provided four ovens which are seen mounted on their control desks on the left of the wicket gate in Fig. 1. These ovens are for normal conditioning, tropical conditioning, hot drying (50-100°C.) and hot drying (100-200°C.) respectively. They are all furnished with circulating fans and the "hot" and "tropical" ovens are also fitted with thermostats and Metrovick tubular heaters. A humid atmosphere in the "normal" and "tropical" ovens is provided by a tray of water or salt solution which can be heated if necessary.

A feature of particular interest is the double interlocking of the supply for considerations of safety. The supply, which can be at any voltage up to 35 kV., is brought by an extension of the tubular busbar into the top of the oven through an isolator and an insulating bushing. The isolator in its fully-open position operates an interlock

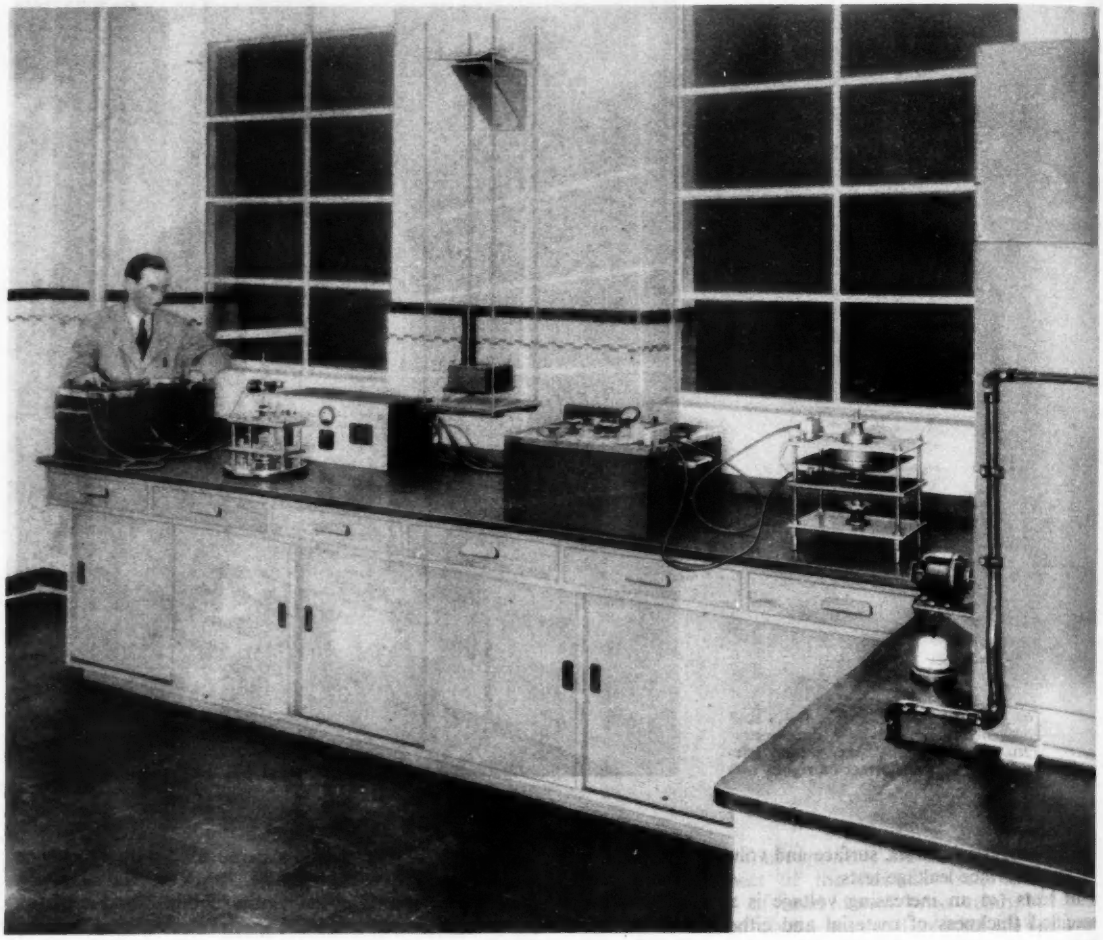


FIG. 4.—The insulation resistivity test in progress and the audio-frequency Schering bridge in three sections.

which is in parallel with one on the oven door so that the latter cannot be opened even partially without switching off the high voltage transformer unless the isolator has been opened first. There is also a small window in the door, interlocked in a similar manner, which gives access to the oven interior without seriously affecting the temperature. This arrangement of isolators and interlocks ensures that the shutting down of one oven does not affect the others. The testing cage is also interlocked electrically so that opening its door automatically cuts off the supply.

The testing equipment for surface and volume resistivity is seen at work in Fig. 4. It employs the method of measuring the current through the specimen produced by a known d.c. voltage across it. This current is determined by a sensitive reflecting galvanometer with a scale length of about 13,000 m.m. per micro-ampere at a distance of 1 metre. It is suspended on a vibration-proof platform from a bracket on the wall joist. The d.c. voltage is supplied by a potentiometer controlled voltage doubler circuit employing Stabilovolt tubes and fed from Westinghouse rectifiers. The electrodes are of mercury or graphite in accordance with B.S.I. recommendations. The surface-leakage tester comprises an ordinary "megger" in conjunction with a special comb which has twenty-five contact points ¼-in. apart and alternately positive and negative.

The installation as a whole is an example of the effective results obtained by integral planning as opposed to piecemeal handling of an installation of this nature.

Acknowledgments are made to the Turners Asbestos Cement Co., Ltd. for the permission and facilities so kindly granted for the publication of this article and for permission to reproduce the illustrations.

Viruses and Insects

KENNETH M. SMITH, D.Sc., F.R.S.

"YET I have found that the sap of leaves attacked by the mosaic disease retains its infectious qualities even after filtration through Chamberland filter-candles." It was with these words, spoken just over half a century ago, that Dmitrii Iwanowski announced his discovery to the world, the first scientific demonstration of the existence of the so-called filterable or ultra-microscopic viruses. He had shown that a sterile filtrate, i.e. one from which all living organisms—as we conceive such things—had been eliminated, was still infectious and had the power of reproducing the mosaic disease, so named because of its mosaic-like pattern of light and dark green, in healthy tobacco plants. Little attention was paid to this at the time, and even Iwanowski himself failed to grasp the significance of his discovery. He seemed to think that tobacco mosaic, the disease in question, was only another bacterial disease but caused by very small bacteria. Nevertheless by his discovery Iwanowski opened the door to a vast field of scientific endeavour and one which profoundly affects the health of man, of his crops, and of his animals. But not only that, viruses are so close to that indistinct and shadowy boundary which separates the "living" from the "non-living" that their study leads inevitably to speculations on the nature and origin of life itself. Modern methods of approach to the virus problem have shown that these agents possess attributes which are characteristic both of what we call "living" and "non-living". Viruses indubitably possess that fundamental property of life, the power to multiply. They can also mutate or change their character slightly, and they are easily destroyed by heat and disinfectants. These properties are characteristic of "living" things. On the other hand, many viruses are so small that they are far beyond the resolving power of the best microscope lenses using visible light. Some indeed are almost of molecular size, and it is difficult to conceive of these as being organized. Again, it is now possible to purify and concentrate certain viruses until they become crystalline and, in fact, behave like a chemical substance.

The study of viruses has now become such a complex and fascinating discipline that the biologist has been joined by other workers from many apparently unrelated fields. In recent years the physicist, the biochemist, the serologist, and the statistician have all made important contributions to our knowledge of these agents.

Two characteristics of viruses are outstanding; one is the impossibility of cultivating them in a cell-free medium, such as broth or an agar slope, as can be done with many bacteria. They must have a *living cell* in which to multiply. The other characteristic is their close and apparently complex relationship with insects upon which many viruses depend for their transmission from diseased to healthy hosts. This relationship with insects has been developed to a greater extent with viruses than with any other agents of disease. It is with this second characteristic that the present article is mainly concerned.

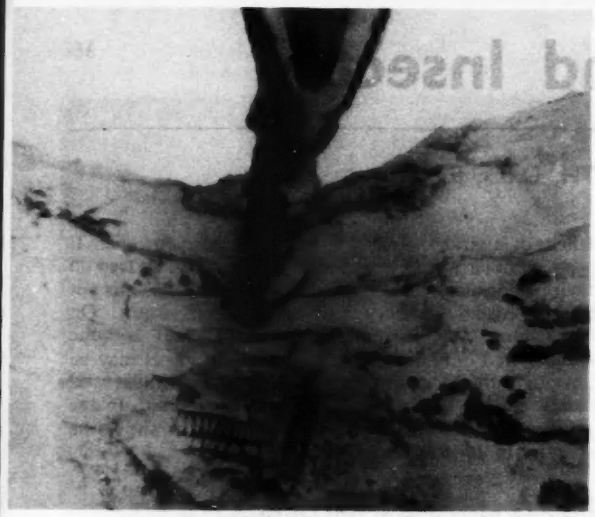
It is fairly obvious that to be a carrier, or *vector* as it is called, of a virus the insect must be a predacious one. It must, in other words, attack plants or animals and feed on their sap or blood. Even so, as will be seen later, it is not every predacious insect which can transmit viruses. On the contrary the relationship in many cases is quite specific, and only one particular species of insect may be able to transmit a given virus while other similar and closely related species are quite unable to do so. In the same way an insect will spread only one virus and so be selective in its virus transmission.

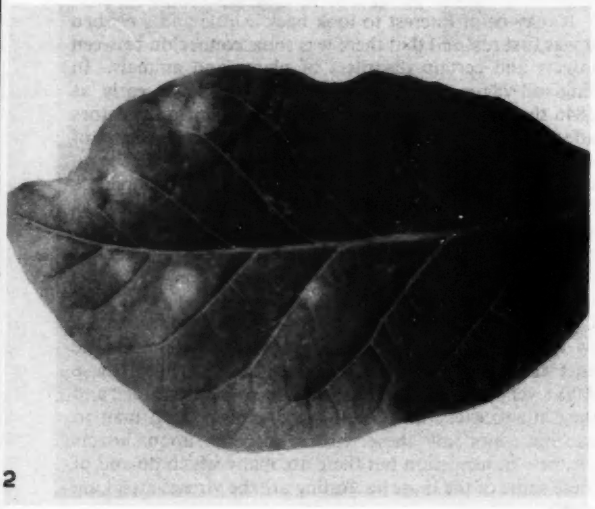
Insects as Disease Carriers

It may be of interest to look back a little and see when it was first realized that there was some connexion between insects and certain disorders of plants and animals. In England vague suggestions had been made as early as 1846 that aphides or greenfly were abundant on potatoes affected with the "curl" disease. The first real evidence of a connexion between an insect and a disease, since shown to be due to a virus, seems to have been given by a Japanese farmer about the year 1894. He showed that there was some relationship between the so-called "dwarf" disease of rice and a sap-sucking insect known as a leafhopper. So far as virus diseases of man himself are concerned, it was in 1900 that Walter Reed, following up the suggestion of Carlos Finlay, showed that yellow fever was transmitted by a mosquito, although it was not known until a little later that yellow fever was a virus disease. Since those days a very large number of viruses have been recorded and they attack every kind of living organism from man to bacteria. Not all these viruses depend upon insects for their transmission but there are many which do and of these some of the most interesting are the viruses attacking plants.

Insects which feed on plants can be divided into two groups, the leaf-biters such as caterpillars or beetles and the sap-suckers, of which the aphis is a well-known example. Now if we examine the insects which have been shown to transmit plant viruses we find that about 99% of them are of the sap-sucking type and belong to the insect order Hemiptera. The mouthparts of this type of insect consist of a very fine tube, made up of two pairs of stylets. On the inner faces of the stylets are two pairs of grooves which approximate closely to each other, thus forming two canals. Down one of these canals flows the salivary secretion of the insect and up the other is sucked a mixture of sap and saliva (see Fig. 1). It is the saliva of the infective insect which acts as the vehicle of virus infection and an experiment demonstrating this will be described a little later.

The two main groups of Hemipterous insects which are concerned in the spread of plant viruses are the aphides and the leafhoppers but there are other members of this family which are vectors and also one belonging to another order, the Thysanoptera or thrips (see Fig. 2).





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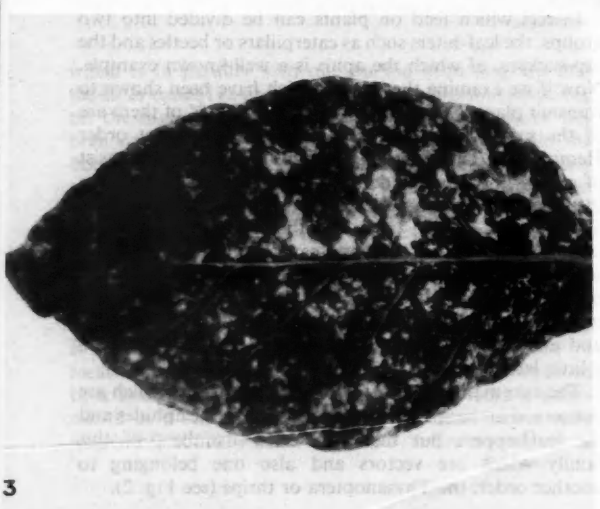

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Before discussing the relationship between viruses and insects we must explain certain routine experiments which are part of the plant virus worker's stock-in-trade. Workers with animal viruses usually have some small easily reared animals such as mice, rats, guinea-pigs or rabbits which react to virus inoculation in some characteristic manner and so act as indicators of the presence of virus. Plant virus workers use various species of plants in a similar way, and chief among such "plant indicators" is the tobacco plant. For some reason it seems to be more susceptible to virus infection than any other plant.

Relationship between Viruses and Insects

The relationship between plant or animal viruses and their insect vectors is by no means a simple one; moreover it seems to differ greatly with different viruses, at all events so far as plant viruses are concerned. Much more research needs still to be done before we have a clear picture of the situation. Meanwhile we have established a number of rather interesting facts concerning this relationship between insect and virus, some of which are given here.

Let us first understand the various methods, including artificial ones but excluding grafting, by which plant viruses can be transmitted. They are as follows: (1) by inoculation (using that word in the sense of the application of infective sap to the healthy leaf by rubbing); insect vectors for this group, if they exist, have not been discovered; (2) by insect vector and by inoculation; (3) by specific insect vector only.

There are one or two plant viruses which spread in nature by mechanical contact between diseased and healthy plants. We may perhaps include these legitimately in group (1) under the heading of "inoculation". We do not know how the rest of the plant viruses in this group—and they are many—are transmitted in nature since the insect vectors, if such exist, are not known. For the moment we are chiefly interested in the viruses forming groups (2) and (3). Many of the viruses in group (2), but not all, are quickly lost by the transmitting insect, if the latter has not fresh access to the source of virus. These have been called by M. Watson "non-persistent" viruses. Those viruses in group (3) which are not sap-transmissible are usually retained by the insect vector for long periods, sometimes for the rest of its life, without further access to a source of virus. These have been named "persistent" viruses, and some aphis-transmitted and most of the leafhopper-transmitted viruses belong to this group. Now if we think for a moment about these

FIG. 1.—Photomicrograph of the stylets of a sucking insect *in situ* in a potato leaf. The boat-shaped body at the end of the stylets is a drop of saliva in which the virus is carried.

FIG. 2.—Leaf of tobacco which has been fed upon by a virus-carrying thrips, the feeding marks of the insect are the small white dots. Note the symptoms of the disease developing in the form of rings surrounded by a halo. The virus is that of tomato "spotted wilt".

FIG. 3.—Leaf of a tobacco plant infected by rubbing with the sap from a mosaic potato plant. Compare Fig. 4, which is a leaf from a tobacco plant infected by means of an aphis brought from the same potato plant.

persistent viruses the question at once arises, How is it that the insect can remain infective for so long? This immediately leads to another question. Does the virus multiply inside the insect to enable it to retain infection?

This second question has more than a mere academic interest, because if it could be proved that a plant virus multiplies inside an insect then this would be a link between plant and animal viruses. A plant virus which multiplies inside an insect is also in a sense an animal virus. There is not a great deal of information available on this point, but some recent interesting work by L. M. Black offers some evidence of multiplication by one virus in its insect vector. He used in his experiments a virus attacking asters—aster yellows—which falls into group (3) of our arrangement, i.e. viruses transmitted only by a specific insect. In these experiments a number of the insects (leafhoppers) which transmit aster yellow virus were allowed to feed for a given period, say 24 hours, on a yellowed aster. These insects were, of course, known to be free of the virus in the first place, and so being allowed to feed for the same time on the source of infection all received approximately the same dose of virus. The insects were then removed from the aster and allowed to feed only on rye plants which are immune to the aster yellows virus. The next step was to test the insects at regular intervals for the amount of virus they contained. It was found that the leafhoppers tested several days after removal from the aster plant contained more virus than did those tested after the lapse of only one day. In other words the virus content of the insects seemed to increase with time after removal from the source of virus.

Artificial Feeding of Insects

You may wonder how it was possible to test the leafhoppers for the virus they contained when it has been stated already that this virus can only be transmitted by the leafhopper itself. This difficulty was overcome by a technique which has been much used in studies on the insect transmission of plant viruses and consists of a method of "artificial feeding" of sap-sucking insects. The apparatus is simple enough and consists of a small circular glass vessel open at one end and with a hole about a half-inch in diameter cut in the bottom. Across the open end is fixed a very thin membrane. This takes the place of the leaf epidermis. Upon the outside of the membrane are placed drops of the fluid which are to be fed to the insect, and the vessel is then reversed and placed over another vessel of the same size containing a little water. This forms a damp chamber and prevents evaporation of the drops. Next the insects are introduced into the upper glass vessel through the hole cut in the bottom, but which is now the top since the vessel has been reversed. The hole is plugged with cotton wool to prevent the escape of the insects. The leafhoppers take to this sort of treatment quite kindly and feed on the drops of fluid by inserting their stylets through the membrane and sucking up the liquid.

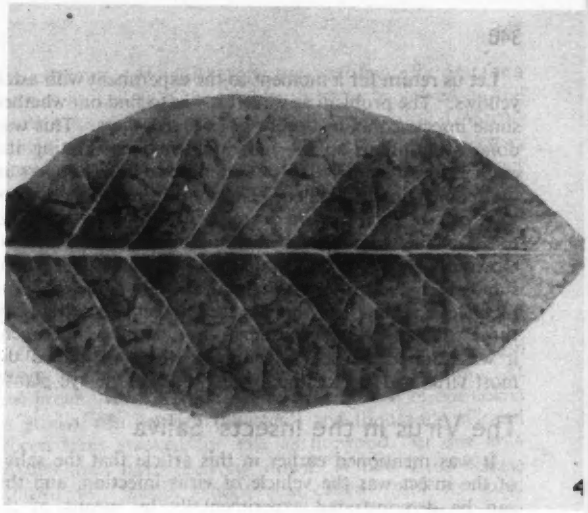

FIG. 4.—Leaf of a tobacco plant infected by means of an aphis from a mosaic potato plant. Compare Fig. 3.

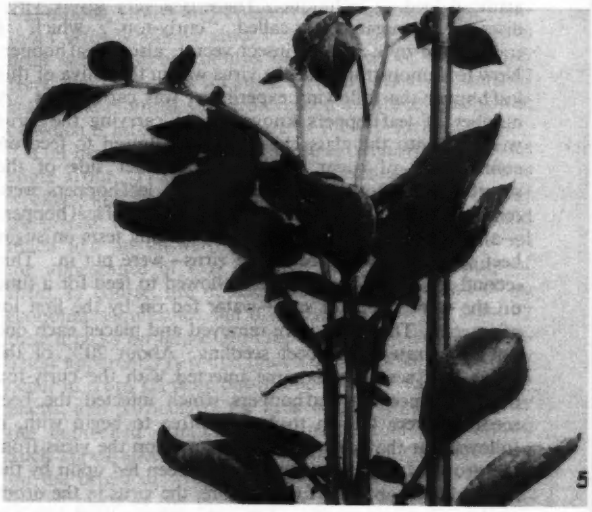

FIG. 5.—Potato leaf-roll: a severe virus disease of the potato, transmitted by an aphis.

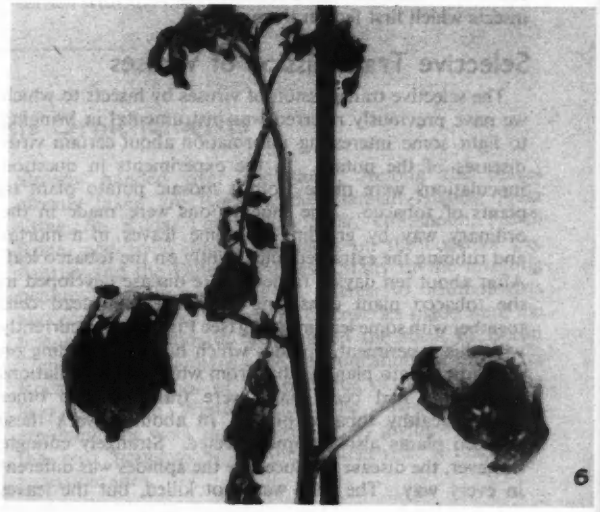

FIG. 6.—Leaf-drop streak: another severe virus disease of the potato transmitted by an aphis.

Let us return for a moment to the experiment with aster yellows. The problem as we left it was to find out whether some insects contained more virus than others. This was done by grinding up the individual insects, diluting the extract, and feeding it to fresh uninfected leafhoppers in the manner just explained. These fresh leafhoppers were then placed, each one on a young healthy aster seedling, to see if they would infect them with the yellows disease. Obviously those leafhoppers which, when crushed, would stand the highest dilution and still contain sufficient virus to infect the new leafhoppers feeding on the extract are those which contained the most virus. In the experiment it was found that the leafhoppers which contained the most virus had fed for the longest time on the rye plants.

The Virus in the Insects' Saliva

It was mentioned earlier in this article that the saliva of the insect was the vehicle of virus infection, and this can be demonstrated experimentally by means of the artificial feeding technique. There is a very severe virus disease of sugar-beet, called "curly-top", which is transmitted by a specific insect vector, also a leafhopper. Now to demonstrate that the virus was in the saliva of this leafhopper the following experiment was carried out. A number of leafhoppers known to be carrying the virus were put into the glass chamber and allowed to feed on some drops of sugar water on the other side of the membrane. After a few hours all the leafhoppers were removed from the chamber and a fresh batch of leafhoppers —all of which had been proved by feeding tests on sugar beet seedlings to be free of the virus—were put in. This second lot of leafhoppers were allowed to feed for a time on the same drops of sugar-water fed on by the first lot of insects. Then they were removed and placed each one on a separate sugar beet seedling. About 20% of the sugar beet seedlings became infected with the curly-top disease. Since the leafhoppers which infected the beet seedlings were known to be virus-free to begin with, it follows that they can only have picked up the virus from the drops of sugar-water which had been fed upon by the infected leafhoppers. Furthermore, the virus in the drops could only have got there from the saliva of the infected insects which first fed on them.

Selective Transmission of Viruses

The selective transmission of viruses by insects to which we have previously referred was instrumental in bringing to light some interesting information about certain virus diseases of the potato. In the experiments in question inoculations were made from a mosaic potato plant to plants of tobacco. The inoculations were made in the ordinary way by grinding up some leaves in a mortar and rubbing the extracted juice lightly on the tobacco leaf. After about ten days a rather severe disease developed in the tobacco plant consisting of patches of dead cells together with some leaf mottling (see Fig. 3). Concurrently with this experiment, aphides which had been feeding on the same potato plant as that from which the inoculations to tobacco had been made, were transferred to other similar healthy tobacco plants. In about a week these tobacco plants also became infected. Strangely enough, however, the disease produced by the aphides was different in every way. The cells were not killed, but the leaves showed a characteristic dark green banding of the veins (see Fig. 4). At the time these experiments were made this seemed a puzzling phenomenon, but a few more experiments gave the explanation. The potato plant in question was infected with two viruses, and while both these viruses were transmissible by sap-inoculation only one of them was insect borne. This explained the difference in the two diseases produced in the tobacco plants, because the aphis was selecting out one of the viruses and this naturally enough gave rise to different symptoms from those arising from the two viruses brought over by sap-inoculation.

Movement of the Virus inside the Insect

Our knowledge of what happens to the virus inside the body of an insect vector after being sucked up from a diseased host is rather meagre. Owing to the ultra-microscopic nature of viruses we cannot make very thin sections of infected insects, stain them with dyes and observe what is happening under the microscope, like Ronald Ross was able to do with mosquitoes carrying the malarial organism. However, some interesting work by H. H. Storey in East Africa has thrown some light on the subject. He worked with a virus disease of maize known as streak, one of those viruses which can only be transmitted by one specific insect, in this case again a leafhopper. Although there was no doubt about the fact that this particular leafhopper did transmit the streak virus, cases were frequently observed where the insect failed to infect the experimental plant. Investigation showed that there was in fact a race or strain of these leafhoppers which could not transmit the virus. There was no anatomical difference to be observed between these two strains and both were indubitably of the same species. By means of the artificial feeding technique already described, Storey demonstrated that the streak virus was present in the *faeces* of this non-transmitting race and *not in the blood*, whereas it *was* in the blood of the transmitting strain of leafhoppers. Now here is the interesting point. When a small puncture was made with a fine needle in the wall of the alimentary canal of the non-transmitting insects, then these insects were able to transmit the virus. If you come to think about the matter, it is fairly obvious that in order to be ejected with the insect's saliva—as we have shown it actually is—and so enter a new host, the virus must somehow pass through the wall of the alimentary canal into the blood and so eventually into the salivary glands. Possibly in the non-transmitting type of insect there was some property in the wall of the alimentary canal which prevented the passage of the virus into the blood. Not long after this work on streak of maize, an interesting parallel came to light in the animal virus world. There is an extremely fatal virus disease of horses in the New World rejoicing in the name of "equine encephalomyelitis", and this virus is carried by the same mosquito as that which transmits yellow fever. Now the horse virus exists in two distinct strains, the *eastern* and the *western*; but the mosquito can only transmit the western strain. However, it was shown by M. H. Merrill and C. Ten Broeck that if the alimentary canal of the mosquito was punctured in the same way as was that of the leafhopper, then the mosquito was able to transmit both strains. Evidently the wall of the alimentary canal plays an

important part in the movement of viruses within the bodies of insects, but what the exact relationship is between the two has not yet been discovered. We do not really know how this virus disease of horses gets about in nature; it is known that several insects and allied arthropods can carry the virus; but the question is, do they actually do so? The mosquito can easily be made to transmit the virus experimentally, but naturally infected mosquitoes have never been found—and similarly with a species of blood-sucking tick. The only insect which seems to have been found out-of-doors actually carrying the horse virus is a formidable blood-sucking insect known as an "assassin bug". It is clear that much more research is necessary before the whole story can be told.

Insect-borne Viruses of Plants

The potato and the raspberry are important crops, so let us investigate a little the so-called degeneration of these two plants. Last autumn there were imported from Scotland into England 440,000 tons of "seed" potatoes. Why should this be necessary? Why cannot seed potatoes be produced in England? The reason is, as every English farmer knows, that the potato plant degenerates so rapidly in this country, except in a few areas, that it would be folly to save home-grown seed. What exactly then is meant by this potato degeneration? Simply that the potato crop becomes impregnated with viruses, the two most important of which (see Figs. 5 & 6) are aphis-transmitted, and since both the potato and raspberry are propagated by tubers and cuttings the virus also is propagated afresh each year. The main reason why the Scotch seed potatoes are superior is the fact that the climate in the seed-growing districts of Scotland is unfavourable to the aphis and without the aphis the viruses cannot spread.

A rather similar state of affairs exists in the raspberry industry, at all events in parts of England. Raspberry crops in the eastern counties have long been badly affected with raspberry mosaic, another aphis-transmitted virus. In order to avoid this state of affairs many of the raspberry growers in the eastern parts of England moved their plantations up to Scotland, where the mosaic disease was less common. Here the crops grew satisfactorily, and for a time it looked as if the problem was to be solved on the same lines as the virus diseases of the potato. Unfortunately within the last year or two a new virus disease, apparently more serious than the mosaic, has broken out in the raspberry plantations in Scotland. This disease, which is of the "leaf-curl" type, is spreading rapidly. No doubt it also is insect-borne, but the identity of the insect vector has not yet been established.

Swollen-shoot of Cocoa

The situation as regards the virus diseases of certain crops at home can easily be paralleled in the tropics. At the present time in West Africa, where most of our cocoa is grown, can be seen thousands and thousands of dead cocoa trees stacked for sale as firewood. In one area 70,000 trees have been cut down. A new virus disease known as "swollen-shoot", so-called from its most characteristic symptom, has appeared in the cocoa plantations. Unlike most plant virus diseases, the swollen-shoot virus is almost always fatal and an affected tree is dead within twelve months of the onset of the disease. Here again this virus is almost certainly insect-transmitted and at the moment suspicion rests upon three insects, one of which is an aphis but all are of the sap-sucking type.

You may ask where do all these apparently new viruses come from. That is exactly the question which virus workers, and especially plant virus workers, are asking at the present time; and it is a question to which they would much like an answer. Hardly a year goes by without the appearance of two or three new viruses. Many of them, of course, are of scientific interest only and of no economic significance, but others, as we have just seen, by their attacks on important crops cause very severe losses. These apparently new and undescribed viruses do not only occur in crops growing out-of-doors; they also appear on plants, and particularly the tobacco plant, growing under the controlled conditions of insect-proof glasshouses. Such appearances naturally give rise to much speculation on the origin of viruses, but these speculations would be out of place in the present article, which is mainly concerned with the insect relationships of viruses.

R.A.F. Helps British Ornithologists

OFFICERS and men of the R.A.F. Coastal Command are playing quite an important part in assisting the research work of British ornithologists by taking aerial photographs of islands, cliffs and rocks populated by birds. Thanks to the efforts of Air Vice-Marshal J. M. Robb, a member of the British Trust for Ornithology, for whom the work is being done, a valuable collection of pictures is being built up. Taken largely on practice flights, these photographs often give detailed information about these rocky strongholds of our sea-birds that could not be obtained by viewing the places from ground level. The Trust have given Coastal Command a list of some 250 places of general ecological interest, and photographs of some of them are being obtained, well over half having been already handed over for study. Among the places already taken are Rockall, the Flannan Islands, Ailsa Craig, St. Kilda, Lewis, Sula Sgeir, Grassholm, North Rona, and some interesting stacks off the coast of Co. Antrim and the Outer Hebrides. Many of the resulting pictures have proved of great interest to ornithologists and ecologists, and among the discoveries made were the first proof of Fulmars breeding on the stack of Eilean Tighe in the Flannans, the identification of birds on Rockall, and proof of the presence of gannets on the Scar Rocks in Wigtownshire. The airmen concerned are doing fine work in this direction by giving evidence of the bird populations of these otherwise virtually inaccessible sites.

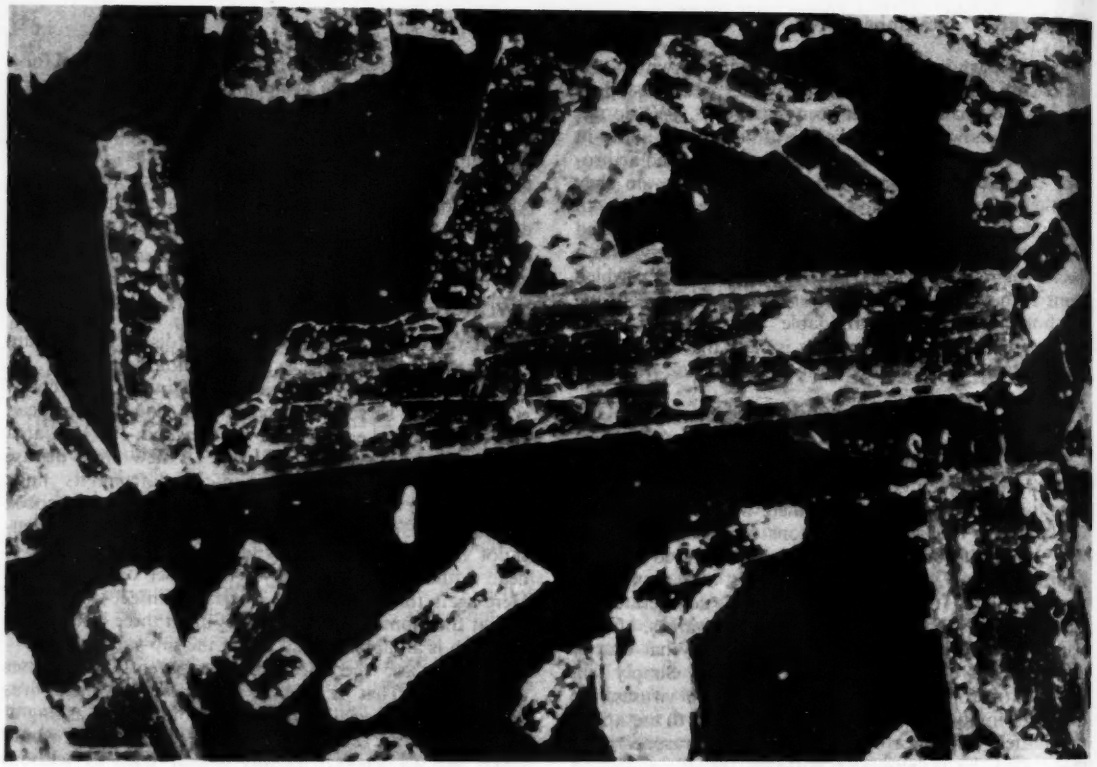

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FIG. 1.—Crystalline vitamin A

Vitamins: accessory food factors

ALAN D. SCOTT, B.Sc., Ph.D.

BY saying that vitamins have assumed enormous importance during the period between the two world wars we state a fallacious truism. It is obviously incorrect, because we know that vitamins must have played an important part in the diet of all but the most elementary forms of animal life since it first appeared on this planet. Yet it is true that vitamins have only assumed their rightful place in the thoughts and calculations of biologists and other scientists within the last quarter of a century. What, then, are these vitamins? What do they do? Of what interest are they to us?

Vitamins are organic compounds which are essential, though in small amounts, for the normal life of animals, and which do not furnish energy, nor are they used as building units for the general structure of the organism. Animals, as a rule, are unable to synthesize these compounds.

This is not a rigid definition of vitamins, but it will serve our purpose. It is to be understood that all animal life does not require all the vitamins; but our knowledge is growing so rapidly that it is well not to be too dogmatic about the vitaminic requirements of individual species. Man, being a highly complex animal, needs a variety of them in order to maintain his biological equilibrium. The absence, or a severe shortage, of one of them may give him for example, scurvy, beriberi or night-blindness. Prehistoric skeletons have been recovered showing signs that their owners suffered from rickets, but it is only recently that such diseases have been attributed to dietary deficiencies, although from the sixteenth century onwards occasional recommendations were made for the use of citrus fruit to prevent scurvy.

At the turn of last century, a crucial experiment was made. As far as was generally known at the time, food consisted of carbohydrates, fats, proteins, salts, and water. In 1897, however, C. Eijkman, in the Dutch East Indies, reported that when he fed his chickens on a diet of milled rice they developed a disease resembling human beriberi, and he also discovered that the disease could be prevented or cured by adding the rice bran to the milled rice. In 1907, two Norwegians, A. Holst and T. Frolich, similarly discovered animal scurvy in guinea pigs.

The appearance of the papers of Sir F. Gowland Hopkins, who has recently retired from the chair of Biochemistry

at Cambridge, proved to be the spark to the gunpowder. He first emphasised the physiological necessity of these "accessory food factors". The required interest had been aroused. Widespread research was commenced. In 1912 C. Funk named these substances "Vitamines", because they were essential to life and he believed that the anti-beriberi compound was an amine (an organic chemical containing the amine "$-NH_2$" group of atoms). By 1915 "Fat-soluble A" and "Water-soluble B" factors had been discovered by E. V. McCollum and M. Davis working in Canada. The close of the last war, however, found the information about these substances in a very sketchy state, and most of our information has been gained since that time.

In 1920, Dr. J. C. Drummond, now Scientific Adviser to the Ministry of Food, proposed that the generic name be altered to "Vitamin" and that the individuals be indicated by the letters of the alphabet. Thus "Fat-soluble A" became vitamin A, and "Water-soluble B" became vitamin B, and the anti-scorbutic factor, vitamin C. This nomenclature has persisted in spite of several developments which have tended to confuse matters. For example, vitamin B is now known to be complex, and the components are known as vitamin B_1, B_2, B_3 etc. In time, the vitamins were identified as precise chemical entities and they were given chemical names. For example, vitamin C is also known as ascorbic acid, although it was formerly hexuronic acid. It is related that when in 1928 A. Szent-Gyorgyi isolated vitamin C without realising its identity, he named it "ignosic" acid, as it seemed to be similar to a sugar he called "ignose". The editor of the journal to which the paper was submitted objected to the name "ignose", so Szent-Gyorgyi suggested "Godnose" as an alternative.

Thus we see that various "deficiency diseases" have come to be recognised as due to the absence of these biological catalysts, the vitamins. Until recently it has been customary to attribute individual diseases to lack of specific vitamins, but it is now beginning to be realised that the vitamins sometimes interact on one another, so that a shortage of one may upset the utilisation of another. Perhaps even more important is the realisation that slight deficiencies of intake of vitamins, while not serious enough to give rise to the well-established diseases, can cause considerable derangement to the living system.

Sources and Requirements

Whence, then, do we obtain our vitamins, and how much do we need? It is fairly easy to say from where they come, but the magnitude of our requirements is still the subject of much debate and experiment.

As has been stated, vitamins are organic chemicals which, in general, cannot be synthesized or built up from simpler compounds by animals. This means that the ultimate source of them is the vegetable kingdom. Consequently the more vegetables we eat, and also the greater variety we eat, the more vitamins we shall obtain. But this is not the whole story. Animals consume the vegetables, and in certain cases surplus vitamins are stored in particular portions of the creatures' bodies, which then become sources of the vitamin.

In trying to assess our intake of vitamins, it must be remembered that even though we know the vitamin content of our food, consideration must be taken of the various accidents which may happen before we can profit by it.

Firstly, the preparation of the food may well destroy the bulk of the vitamin present. For example, a well-boiled cabbage may contain only 10% of the vitamin C which was present when it was growing in the garden. A good deal may be lost while it is travelling from the grower to the market and home to the kitchen, a bit more when it is being chopped up, and by the time father is somewhat late for dinner and it has been kept hot for him very little will remain.

Secondly—although little is known about the matter—it seems certain that the rather vigorous chemical and enzymatic reactions (fermentations) going on in the alimentary tract are likely to destroy at least a small amount of some of the vitamins.

Thirdly, the degree of absorption through the gut wall varies considerably from food to food. Thus carrots are a rich source of carotene, which is a provitamin A (i.e., it is converted into vitamin A by animals, including man), but unfortunately very little carotene passes from carrots through the gut wall, and some 90% may be recovered from the animal's excreta. Yet if the carotene were extracted from the carrots by chemical means and then dissolved in a vegetable oil, say coconut oil, a very large proportion would be utilised.

Vitamin A is stored by the animal if it obtains more than it immediately requires. Conversely, it can exist on its reserves for an appreciable time if its diet suddenly becomes deficient in this respect. Any excess vitamin C, on the other hand, is either destroyed or excreted. The animal has no reserves, and it is therefore important that its daily food should contain sufficient of this vitamin.

It is to be expected that an animal will require different amounts of each of the vitamins, and this turns out to be the case. Different authorities are not agreed upon the optimum human daily vitaminic intakes, but the following figures are approximately correct:—Vitamin A 0·003 gramme, Vitamin B_1 0·00015 gramme, Vitamin B_2 0·002 to 0·003 gramme, Vitamin C 0·05 to 0·1 gramme, etc. A better idea of these amounts is obtained by remembering that 1lb. of pure vitamin A would supply the total requirements of a Wembley Cup-final crowd of 90,000 people for one and two-third days. In any case, the requirements vary with circumstances; for example, it is obvious that the pregnant woman needs enhanced supplies.

Effects of Vitamin A Deficiency

Space limitations prevent a detailed description of all the vitamins, and a close survey of vitamin A (Axerophthol) must serve in this respect. A shortage of vitamin A in the diet of an animal or man may effect a number of changes in the body. The most widespread alteration occurs in the skin, but it is particularly prevalent in certain tissues. The surface of the eye tends to dry up (a complaint known as xerophthalmia), and the patient feels as though particles of sand were irritating his eye. In bad cases, an opaque white spot may appear and spread over the surface of the

cornea; ultimately, complete destruction may result. Provided the patient has not suffered any radical injury while the disease is in its early stages, he may be completely cured by the addition of vitamin A to his diet. This ability to prevent and cure xerophthalmia gave rise to the alternative name of Axerophthol for this vitamin. Other epithelial tissues which are particularly susceptible to change under conditions of vitamin A shortage are those of the air passages and the vagina.

As one might expect, a derangement of the normal surface cells of the body tends to facilitate the entry of infection at that point. It was early recognised that animals on a vitamin A deficient diet were more susceptible to certain illnesses than corresponding animals on a normal diet. This effect seems to be primarily due to lowering the local resistance rather than to reducing the potency of the general defence. Consequently, we find that increasing an animal's consumption of vitamin A will only reduce its susceptibilities to infection if it has been deficient in vitamin A; if it has been consuming an adequate diet, no improvement will take place. Thus the description "anti-infection" which has been applied to vitamin A is true only to a limited extent.

One of the specific sites of derangement arising from a deficiency of vitamin A is the retina of the eye. On the surface of the retina are two varieties of nerve cells, known as the rods and the cones, which are sensitive to light. The cones respond to illumination of normal intensity, and are the means by which we see objects in daylight and artificial light, but they are insensitive to dim light. Under such conditions the rods begin to operate. Associated with the rods is a pigment which is the light sensitive agent; this is called visual purple, or rhodopsin. The exact nature of this substance is still obscure, but it is known to contain vitamin A combined with protein. Bright light bleaches or destroys rhodopsin, and consequently when passing from a region of high illumination to one of dimness, it is impossible to see properly until the eye has resensitised the rods. Clearly, the smaller the supply of vitamin A in the body, the longer will it take to accumulate the necessary photosensitive pigment, and in cases of severe shortage the maximum sensitivity attained will be correspondingly reduced. In man "night-blindness" is one of the earliest detectable symptoms of inadequate supplies of vitamin A, and instruments have been constructed with the object of measuring this effect. Whilst the details of the apparatus vary, the principle may be described as follows.

The subject of the test sits in a darkened room, and for a definite short period he looks at an electric lamp, the light from which partially bleaches the visual purple of his retinas. After the lamp has been extinguished for a certain length of time (e.g. ten minutes), a measure is made of the minimum illumination he requires to distinguish test objects (usually numerals or geometrical figures), placed in front of him. With a particular instrument and set of conditions, direct comparisons can be made of the responses of different individuals; and the light required is found to vary very considerably. Persons who need appreciably more light than the normal amount are said to suffer from "night-blindness". Such poor vision is not necessarily due to a vitamin A deficiency, but in many cases it is found that shortly after taking a massive dose of the vitamin, improved or normal dark adaptation takes place during a re-test. Any improvement is maintained as long as, but little longer than, the enhanced consumption of vitamin is continued.

Sir Edward Mellanby, in his recent Croonian Lecture before the Royal Society, once more drew attention to the effect of lack of vitamin A on the nervous system, but his explanation was new. Certain young experimental animals on a vitamin A deficient diet were found to develop a lack of co-ordination of movement. Close examination revealed that portions of the bony structure of the skull were abnormally large, with the result that the whole of the central nervous system was subjected to unusual squeezing pressure. Whereas it is well known that vitamin D plays an important part in the hardening of bones, it now seems probable that vitamin A exerts some control over the formative processes.

Vitamin A and the Pro-vitamins

The earliest workers in this field had discovered that the biologically active material which we now recognise as vitamin A occurs naturally in cod-liver oil, milk, and butter. In 1919, Professor H. Steenbock in America discovered the vitamin A activity of some of the carotenoids. (These are highly coloured red pigments which are very widely distributed throughout the vegetable kingdom.) A year later he also discovered that vitamin A which occurs in fish oils may be concentrated into the unsaponifiable fraction. Oils (other than mineral or petroleum oils), when treated with alkali yield a soap and glycerine, but in addition they always contain a small amount of material which will not react in this way. This is called the unsaponifiable matter of an oil. Concentrates prepared in this way were much more potent than the natural sources, but they were still far from pure.

As early as 1831, Wachenroder had isolated carotene, the pigment from carrots, but its chemical constitution was entirely unknown until 1906, when Professor R. Willstatter showed that each molecule contained forty carbon atoms and fifty-six hydrogen atoms. Finally in 1930 the results of groups of chemists working with Professor P. Karrer in Switzerland and Professor R. Kuhn in Germany led to the establishment of the detailed constitution.

Also in 1930, Dr. T. Moore in this country, demonstrated that if rats were fed on a vitamin A free diet, the reserves of vitamin stored in their livers were ultimately exhausted. Further, if carotene were then incorporated in their diet, the stores of vitamin A rapidly reappeared. It was evident that the rat could convert carotene into vitamin A. Since this time, carotene and a few other related carotenoids have been recognised as pro-vitamins A.

In 1931, Karrer obtained a sufficiently pure preparation of vitamin A to establish its constitution. It may be regarded as the alcohol corresponding to half the carotene molecule.

As yet no one had ever handled pure vitamin A; highly potent concentrates represented the nearest approach. These concentrates were all rather viscous oily liquids, but chemists were convinced that the vitamin (assuming the accepted formula to be correct), ought to be a solid. The melting points of pure substances are depressed by impurities, in many cases very considerably. Conse-

quently, if a solid could be obtained with a definite melting point which would not be increased by any known methods of purification, it would have a good claim to the title "Pure Vitamin A".

In 1937, H. N. Holmes and R. E. Corbet did obtain yellow crystals when they cooled to low temperatures a vitamin A concentrate dissolved in methyl alcohol. The melting point was 8°C, but while this was a great step forward, it was still felt that this was too low. Finally, in 1940 J. G. Baxter and C. D. Robeson prepared crystalline vitamin A (yellow prisms) melting at 63-64°C. They also brought forward good evidence that Holmes and Corbet's crystals had retained a portion of the methyl alcohol solvent. A number of esters, (products of reaction between alcohols and acids) such as vitamin A acetate and vitamin A palmitate, have now also been obtained in the pure crystalline state.

A chemist can easily write out innumerable formulae of possible compounds which have never yet been made, but in most cases, the results of such "doodling" would not rouse in him sufficient enthusiasm to attempt to synthesize them. A compound such as vitamin A, however, as soon as its formula was known, would become to chemists an object only comparable with the summit of Everest to mountaineers. When the difficulties encountered in purifying the naturally occurring material are remembered, some idea may be obtained of the obstacles met with in the quest of this "Holy Grail". Considerable efforts have gone into attempts to synthesize the vitamin, and in 1937 Professor Kuhn and Dr. Morris reported that they had succeeded. This was prior to the isolation of pure crystalline vitamin A, and their final product was only claimed to contain 7·5% of the vitamin. So far, no report has appeared that this synthesis has been repeated; two papers have, however, been published which not only state that the authors were unable to repeat it, but that certain stages of the process yielded products other than those stated by Kuhn and Morris. The synthesis of pure vitamin A, therefore, like the ascent of Everest, remains as an outstanding problem awaiting further developments.

Vitamin A is an exception to the rule that vitamins are chiefly found in vegetables, but it is largely of vegetable origin. The vitamin itself does not occur in plants; but its precursor, carotene, is almost as widely distributed as the ever-present chlorophyll. Usually the green pigment completely masks the presence of the red one, and few would suspect that grass, lettuces, cabbages and many other plants contain the same material to which the colour of carrots is largely due. Cows, besides many other animals, are able to convert carotene into vitamin A, and as a result it is found that milk, butter, and eggs are valuable sources of both vitamin A and carotene. In general, animal flesh and fats are poor sources of supply, but the livers constitute rich deposits. The quantities of biologically active material in these natural products vary considerably, and in some cases, there is a considerable seasonal fluctuation. Winter and early springtime dairy produce may be very poor sources of the vitamin.

For commercial use, it is too expensive to prepare pure carotene or pure vitamin A except for rare purposes. In both cases, highly potent oily concentrates are used. Carotene concentrates are usually made from grass, but vitamin A is prepared on a large scale from fish and whale livers. (The distinction is made because whales are not fish, but mammals.)

Although emphasis has been laid on vitamin A, it must not be considered a typical vitamin. There is no such thing; they all differ from each other. All are chemically unrelated. Investigations into their several chemical and physiological properties have progressed with different degrees of success. For example, vitamins B_1, B_2 and C have not only been synthesized in the laboratory, but they are now manufactured on a large scale.

Vitamins in War-time

As has been stated, by the end of the last war little was yet known about vitamins. Has the knowledge gained since then been made use of during the present conflict? To a large extent official information is lacking, but certain matters have been made known.

The rationing of the last war was devised with little knowledge of vitamins; although enough was known, for example, for a Committee of the Royal Society to warn the Government that it should continue to import fresh fruit or the health of the people would be harmed. The rationing of to-day bears the stamp of the nutritional expert. Children and expectant mothers receive priority supplies of eggs, milk, cod-liver oil, orange-juice, and oranges. Everyone is encouraged to grow a substantial supply of vegetables, particularly greens, which will help to carry him through the winter. Wide publicity was associated with the vitamin B_1 content of the national loaf. Margarine is largely composed of vegetable oils which are without vitaminic activity, and was, in the last war, a bad substitute for butter in this respect. About a dozen years ago, manufacturers started to add vitamin A and D concentrates to a few brands, but shortly after the outbreak of this war, it was announced that all margarine would in future contain as much vitamins A and D as "grass-fed" butter. This meant that throughout the year, all margarine would contain as much vitamin as normal summer butter. A few months later, the official amount of vitamin D was doubled.

Scurvy was very troublesome to our Mesopotamian army, and in 1916 alone 11,000 men were invalided home as a result of this complaint. Recently it has become known that we and the Americans have been supplying our desert armies with vitamins, and it may be concluded that our widespread Forces are receiving such supplementary vitamin rations as their local nutritional supplies may necessitate.

A recent statement indicates that less chocolate will be available for future civilian requirements. It has been decided that chocolate is the best vehicle for getting vitamin supplies to the peoples of Europe when they are liberated. One-ounce bars are being made, each enough to satisfy a child's total daily requirements of vitamins A, B, C and D.

Vitamins and Nutrition

Occasionally there is a tendency to overrate the vitamins; they are by no means the only pebbles on the nutritional

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A New Social Science?

By J. FERRABY

It has been more and more realised since the start of this century that the age in which we live presents problems for solution of an entirely different order from those of the past. In this age it is no longer possible to consider mankind as a collection of individuals; it is necessary also to consider vast groups of human beings, the members of which are subjected to common influences in a way which has never before been the case. A moment's thought makes it clear that large groups subjected to a common influence will not behave in the same way as a collection of individuals each subjected to the same influence separately. Consequently in this age we must take account of mass reactions as well as the reactions of the individual.

In the field of politics the importance of the reactions of masses of people is becoming recognised. Modern propaganda in all its forms is only an attempt to induce in the majority of a mass of people an attitude favourable to the point of view it is desired to propagate. But it is not yet clearly recognised that it is possible to study scientifically the relation between a mass stimulus, affecting large numbers of people, and the effect which the stimulus will have on the mass of people it affects. When this possibility is clearly recognised a new social science will have been born, which may provisionally be termed Mass Psychology.

In order to understand the problems which Mass Psychology should attempt to solve, it is necessary to become aware of the form mass reactions take. The population of any country is continually being subjected to a large number of different influences. Some of these are short term influences whose effect becomes immediately obvious; others are long term influences whose effect is cumulative rather than immediate. Any individual is subjected to a large number of such influences, each of which affects also a considerable mass of other individuals; but so great is the number of possible influences to which any individual may be subjected that probably no two people are ever affected by precisely the same set of different influences. It may in fact be said with equal truth that the circumstances leading to the formation of an individual attitude are different for each individual; and that in this age attitudes are formed by influences which act on large numbers of people in the same way.

In the past the reactions of the individual could be considered with reference only to his internal psychological state, and to the circle of his immediate contacts; now it is necessary also to consider the innumerable mass influences which act upon him. An additional type of influence is now at work, and the scientific problems raised by this new influence demand a new branch of social science to provide a technique for studying them. One of the reasons that the social sciences have not advanced at great speed is that their techniques are adapted to the old type of situation in which the starting-point for study is the individual and his immediate contacts. The new branch of Mass Psychology would take the mass stimuli affecting large numbers of people and the mass reactions of large groups as its starting-point.

An essential difference between the reactions of a mass and the reactions of an individual is that a mass of people rarely reacts with a single reaction. Rather there are a number of different tendencies in the mass, some of which are more frequent or more intense than others. For example, at a time when there is some criticism of the war effort, not everyone will criticise openly. Some will apportion blame to the government, some to those in charge of industry, some to the people themselves. The mass reaction consists of a number of different tendencies, not more than one of which is likely to receive expression from any single individual, although it is possible that most of the more important tendencies could be detected to some extent in the thoughts of many individuals. Further research may show unexpected correspondences between various tendencies in the mass and tendencies in the mind of the individual, but until a science of Mass Psychology has been established such correspondences can only be conjecture. The probability that Mass Psychology may also throw light on the reactions of the individual, however, is apparent.

It is hoped that enough has been said to indicate the need for a new science of Mass Psychology. Its applications need further discussion. As a pure science it should lead to a greater understanding of the workings of a modern society and of the individuals of which the society is made up. In this realm the existence of the problems already discussed is a sufficient justification for a new science to explore their intricacies. But Mass Psychology should be more than a tool in the hands of pure science; it has ramifications in the practical world which are of the greatest importance.

This war and the last have brought into the foreground the importance of propaganda, which has already been referred to as an attempt to induce in the majority of a mass of people an attitude favourable to the point of view it is desired to propagate. It was an intuitive knowledge of mass reactions which enabled Hitler to impose his ideas on the German people. A scrappy and often inadequate knowledge of mass reactions has led the authorities in this country to embark on several propaganda campaigns which have been a waste of effort and sometimes even have produced the opposite effect to the one intended. Belatedly the government set up an organisation to study the nature of public reactions to particular problems; but even now there has been no recognition of the importance of a scientific study of how masses of people are likely to react to different types of situation; and little is done to investigate the effects of an unco-ordinated propaganda in order to avoid once made mistakes, or discover fresh means of gaining the desired end.

Propaganda is the most ostentatious of the applications of Mass Psychology, but it is far from being the only one. In economics it is becoming more and more recognised that an important factor, perhaps the most important factor of all, is the "psychological factor". Economics is concerned above all else with the reactions of masses of people, and the "psychological factor" is a problem for Mass Psychology. Vague terms such as "confidence",

"industrial morale", "fashion", "inertia" both of capital and labour, conceal psychological realities which can be fully understood only when considered in terms of mass reactions. A proper understanding of Mass Psychology would enable economists to introduce into their calculations considerations which at present are often ignored on the grounds that they are outside the subject-matter of economics, too often with the result that intricate deductions are based on faulty psychological assumptions.

In political theory the reactions of masses of people are the very stuff from which conclusions must be drawn. Political theorists are accused of concerning themselves with paper schemes which bear no relation to reality. The missing link which prevents political theorists from relating their theories to practice in a practicable manner is the failure to understand the behaviour of people in great masses.

In politics itself the value of a knowledge of Mass Psychology is manifold. Omitting all reference to the gaining of power by a party, there are uses for Mass Psychology which are less open to abuse. Often a government may be uncertain or mistaken about the order in which various agreed reforms should be introduced. Reforms which are of apparently small importance may prove to be of first rank importance when the psychological effects of the reform are considered. Misunderstandings between a government and those governed can be neutralised, thus partially avoiding the swing against the government in power which is not based on reason. Prejudices could be overcome, so that good and profitable measures would less often be discarded because the people were not yet ready for them. By a proper understanding of Mass Psychology a government could be freed to a great extent from the emotional, prejudiced, unreasoned forces which play so large a part in any system of government calling for acceptance by the mass of the population.

It is true that a knowledge of Mass Psychology is a dangerous knowledge, which is open to grave abuse if misapplied. It could be used by an unscrupulous minority to impose its will on the majority, as has already happened. It could be used by competing parties to intensify the struggle for political power at the expense of the population. In its essence a knowledge of Mass Psychology gives the opportunity for the few to influence the many to a far greater degree than has hitherto been possible. But to discard the new science on these grounds would be foolish, for if those capable of using such power do not develop it, it will fall into the hands of those who will abuse it, and this is the present tendency. Just as the power of machines may be used to good or bad ends, to construct or to destroy, so the power of social science may also be used for the advancement or degradation of mankind. It is no solution to shut one's eyes to the existence of such power; what is necessary is courageously to recognise both the potentialities for good and for evil lying within it, and to make every effort to ensure that it is used to a good end.

If it would be ensured that the power could be used to good ends, Mass Psychology has importance in other ways than the ones named. Principles which apply to masses measured in millions of individuals will apply in some degree also to smaller masses measured in hundreds or thousands. Industrial disputes often arise for reasons other than the stated reason. For example, a strike in a factory may arise from bad temper caused by bad ventilation, which leads to an exaggerated importance being attached to an otherwise trivial grievance. Inharmonious relations between employers and employees may arise from too great an insistence on a rigid discipline. A proper study of conditions would often enable one trained in Mass Psychology to locate the cause of disharmony, and to remove it with only a small sacrifice by either employer or employee. Already some headway has been made in this direction by industrial psychologists.

It is often said that a reason for bad local government in some districts is the inertia and lack of interest of the electorate with regard to problems which vitally concern them. A study of Mass Psychology would help to locate the cause of this inertia, and to awaken interest in problems which are really important. Newspapers, film companies and others allege that if their standards are low, this is because the public desires a low standard. Mass Psychology would assist such bodies to raise the standards of their productions while still obtaining an adequate return for their labours. All the influences capable of educating the public could be used to their best advantage. In a hundred different ways a knowledge of Mass Psychology would assist efforts to better the lot of mankind. As a tool of goodwill the value of Mass Psychology cannot be overstressed. In some of its applications however it might be necessary to develop goodwill before it would be safe to enlarge upon the knowledge of Mass Psychology already achieved in these fields.

But this is not at the present time a real problem, for the knowledge of Mass Psychology already existing among those engaged in the more dangerous fields is far in advance of that possessed by scientists. They are examples of the manner in which such knowledge grows when the time is ripe for it, whether pure scientists countenance the growth of it or not. If such knowledge is not to be abused, scientists must raise themselves to the level of knowledge possessed by those with an axe to grind, so that the knowledge can become common property and its use be controlled.

So far little attempt has been made by scientists to study this subject. It is only recently that a science of social psychology has been recognised, and the study of this science has been conducted for the most part in such a way as to eliminate the possibility of reaching conclusions of value to Mass Psychology. For the tendency, as was pointed out before, has been to start with the individual and then to consider individuals in groups, whereas a true science of Mass Psychology can only start by considering individuals in the mass. Starting from this point, the problems to be faced are of a quite different order from those at present considered by social psychology in most of its aspects, and the appropriate technique is likely also to be different.

Other sciences bear only indirectly on the problem. Psychiatry has produced results of value, but its application has been also from the individual to the mass, so that there has been little attempt to study the mass with a mind freed from preconceived ideas concerning the individual. Anthropology uses methods which can be applied to a study of the Mass Psychology of the society to which the

investigator belongs, but which have seldom been used for this purpose. Sociology is still uncertain whether it is a moral or a practical science, and any work of value to Mass Psychology has been subordinate to other work. What has been done with regard to Mass Psychology in all these fields is of a very scrappy nature, and will only be of value when co-ordinated into an independent science.

The most direct approach to these problems has been made by the organisations which are concerned with the study of public opinion, of which Mass-Observation[1] is one. In this country and to a lesser extent even in America, these organisations are severely handicapped by the necessity for earning enough money from their work to support their researches. They cannot research solely into those problems which they believe to be of value, but must keep always one eye on the investigations which can be expected to bring a return in the form of cash. Good work is difficult to do under these conditions.

Public opinion research is in reality only one branch of the wider science of Mass Psychology, but in the absence of any other working branch it has had to include within itself much of the wider field. Some of the organisations limit themselves more than others in this respect; Mass-Observation has attempted to cover a wider field. This has been possible because stress is not put on the numerical aspect of results to the extent that it is by most public research organisations. It is a first principle among statisticians that figures are of value only when they are correctly interpreted, and Mass-Observation believes that accuracy in interpretation of results is of greater value than extreme accuracy in the obtaining of figures. The figures obtained by Mass-Observation therefore have a wider margin of error than those obtained by most organisations, but material is also given in quoting the results which enables conclusions regarding the meaning of the figures to be reached with greater certainty than by other methods. Sometimes an investigation is found to be best conducted without any reference to figures at all, as for example in examining the condition of morale in towns which have been recently been raided.

The methods of Mass-Observation may be listed under five main headings: (a) Direct Interviewing; (b) Indirect Interviewing; (c) Overheard Remarks; (d) Observation; (e) Various methods involving the co-operation of a panel of voluntary observers.

In Direct Interviewing a sample of the population having the same class, age, and sex proportions as the country as a whole is asked a list of six questions. Mass-Observation's use of this method differs from that of other bodies only in that the answer is taken down verbatim instead of being listed under one of a few headings. By the use of direct questioning figures for the frequency of different types of opinion on any matter are obtained. But this method only touches the surface of opinion, and it is supplemented by the other methods, which are designed to reveal opinion at a greater depth.

When people know they are being interviewed they are often careful about what they say. To release this constraint opinions may be obtained by getting into casual conversation with the contacts without telling them that an investigation is being carried out. Even then the comments are the sort of comments made to a stranger, so a special value is attached to overheard remarks which are usually made to an acquaintance or friend. Some things people are scarcely conscious of themselves, and these can best be investigated by the observation of behaviour under special conditions, for example when an air-raid warning sounds. But perhaps the most valuable way of all to obtain a rounded picture of what people are thinking is by the use of a panel of voluntary helpers who will describe their feelings. Mass-Observation has had such a panel since its foundation, by Tom Harrisson and Charles Madge, in 1937. Besides giving their own attitude, often in detail, this panel assists the investigations in a variety of ways such as keeping a diary which they send to the Mass-Observation office, sending letters from friends containing interesting comments, and even on occasions carrying out interviews themselves on special topics.

By the use of these methods a quantity of raw material is obtained from which a report is written. At present these reports are most frequently on public opinion with regard to various matters, but they may also be more comprehensive, relating to industrial morale in a factory, the habits, opinions and behaviour of pub-goers, conditions in a blitzed town, or almost anything else. In the preparation of these reports from the raw material a new technique is being developed, which may well have application to other branches of social science.

Although the aim of these studies is not usually to investigate Mass Psychology as a pure science, inevitably the continued contact with the attitudes of people in large masses gives the investigator experience which is essential in any study of Mass Psychology. Ultimately it is not possible to study the psychology of people in the mass without first investigating attitudes and behaviour of masses of people. The results which are now being obtained in this exploratory work will no doubt act in the future as raw material on which the Mass Psychologist can base his conclusions.

In the present state of development of the infant science of Mass Psychology the stress is too much on the obtaining of information, and not enough on the significance of the information obtained. This is inevitable when the workers are so few; there are insufficient workers in the field for a satisfactory division of labour. Nevertheless the knowledge of Mass Psychology to be derived from public opinion research is probably far greater than that to be gained in any other way, and if the new science is to be born at all, it is likely to be on the work now being done by the public opinion research organisations that it will be built.

[1] Mass-Observation is an independent organisation, run by Tom Harrisson, investigating the way ordinary people think and behave. It works through a team of full-time, scientifically trained objective investigators, supplemented by its National Panel of some 1500 voluntary informants living in all parts of the country. Its fieldwork headquarters are at 82 Ladbroke Road, London, W.11.

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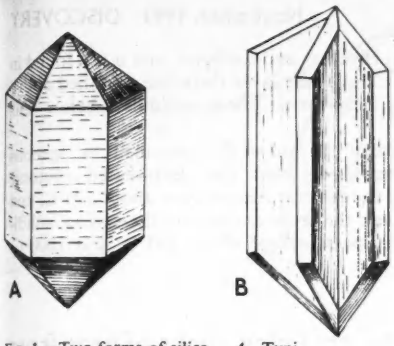

FIG. 1.—Two forms of silica. *A*. Typical crystal of quartz. *B*. Three plate-like crystals of tridymite.

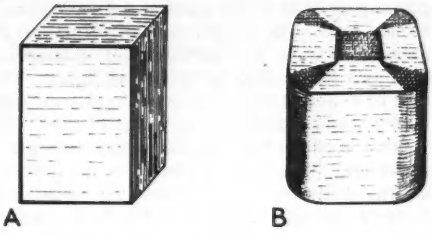

FIG. 2.—Two forms of aluminium silicate. *A*. A crystal of andalusite. *B*. A crystal of chiastolite showing the typical black inclusions in the form of a cross.

Geological Thermometers

By ARTHUR BRAY, M.Sc., A.Inst.M.M.

TEMPERATURE is usually measured by the use of thermometers of one type or another and whilst a particular reaction is in progress; but in the case of reactions which occurred many millions of years ago, and were completed in the far-distant geological past, we must rely on the known temperature relationships of the various minerals which are found in rocks and ore bodies. This article deals with the latter category and is a discussion of the temperatures at which some geological processes take place.

These geological reactions may have taken place at about atmospheric pressures, as in the case of salt deposits, or from warm solutions under slight pressure as in mineral veins, or from melts of rock at very high temperatures and pressures as in the case of plutonic igneous rocks. The plutonic rocks whilst still in the molten condition forced their way into already existing rocks, and solidified deep in the earth, under a thick cover of sedimentary and other rocks. They are many thousands of cubic miles in volume and cooled very slowly. The way in which such large masses of rock were forced into their present position is one of the major problems of geology. During the cooling of these molten plutonic rocks, many mineral changes occur. Minerals formed at a high temperature may not be in equilibrium with the surrounding molten rock at a lower temperature.

They will therefore be resorbed or corroded and attacked by the surrounding molten rock and replaced by other minerals more stable at the lower temperature. Thus it is the final stage of solidification of which we have a record in the rocks. Lavas extruded on the surface usually solidify at a higher temperature than the deep-seated igneous rocks, and at much lower pressures, and for this reason they have a different crystal structure and a different suite of minerals contained in them.

The effect of Rate of Cooling

In the case of the deep-seated plutonic igneous rocks, cooling is very slow. The gases such as steam, fluorine, boron vapours, carbon dioxide, chlorine, etc., are unable to escape through the thick cover of the overlying rock, and are therefore retained in the cooling melt. The effect of these retained gases is to keep the molten rock fluid over a much longer period and to a much lower temperature than would otherwise be the case. The melt may become supercooled, giving the crystals forming the rock a much longer time in which to grow. The crystals are therefore large in size, as seen in most granites. In lavas erupted on the surface on the other hand, the fluxes and gases are rapidly lost to the atmosphere, and because of this, the lavas quickly solidify and at a much higher temperature than the deep-seated rocks. The crystals do not have the opportunity to grow to a large size, so that the rock consists mainly of very small crystals or of a natural non-crystalline glass. Because of this high temperature solidification, different combinations of minerals may be found in lavas when compared with plutonic rocks.

Effect of Temperature on Type of Mineral formed

The temperature of solidification or of melting of many minerals has been experimentally studied. The figures obtained vary somewhat according to whether pure or naturally occurring mineral is used, as few natural minerals are free from gases, which may have the effect of lowering the temperature of solidification. Many minerals also change their form at temperatures below that at which they melt. The mineral silica changes to the mineral tridymite, of the same chemical composition, long before it fuses and melts. The mineral wollastonite only exists at temperatures below 1180°C. If this temperature is passed, it changes into another form of the same chemical substance. The presence of certain minerals in a rock therefore gives some indications of the temperatures at which it solidified.

Rocks usually do not have distinctive melting points, but certain minerals crystallise out earlier than the rest and float about in the still molten residue.

The lava from the Stromboli volcano on eruption often contains crystals of the mineral augite floating in the still molten lava. The temperature of formation of augite is about 1230°C., so that the solidification temperature of the rock as a whole must be below this figure. The temperature of a lava at the moment of eruption is seldom below 1000°C., and is probably very much higher.

Silica is one of the most commonly occuring minerals of rocks and veins, and is found in many forms such as quartz, tridymite, and cristobalite, depending on the temperature of formation. All have been artificially produced, and their temperature relationships are known. Quartz crystallises in hexagonal prisms terminated by sloping faces. Quartz, however, becomes unstable at temperatures above 800°C. and changes to the rhombic variety of silica called tridymite (see Fig. 1). When the temperature is raised to about 1470°C. tridymite passes into another form of silica termed cristobalite. This mineral cristobalite is not found in natural rocks, but is a constituent of silica bricks artificially made for the lining of blast furnaces and coke ovens which have to resist high temperatures. Quartz itself exists in two forms, the α quartz being stable below 575°C. only, whilst β quartz forms above this temperature. This change is reversible, so that all quartz now found in rocks is α quartz. But etching the mineral reveals whether the mineral was formerly α or β quartz.

The quartz crystals found in mineral veins was α quartz from the beginning, so that deposition of the quartz in veins must have taken place below a temperature of 575°C. The quartz crystals of most plutonic rocks was originally β quartz, so that these rocks must have solidified at temperatures between about 575°C. and 800°C. The mineral tridymite is fairly rare, and is only found in lavas which solidified at temperatures above 800°C.

The presence of the rhombic mineral enstatite (magnesium silicate) in igneous rocks indicates that final solidification took place at about 1000°C., for at above this temperature a monoclinic variety of the same mineral is formed. Above this temperature of 1000°C. enstatite cannot exist.

Many mineral crystals growing in the molten rock react with the surrounding silicate magma in which they are growing when the temperature falls, and form new combinations of molecules and minerals.

When a melt of the mineral orthoclase (potash aluminium silicate) begins to cool, crystals of leucite begin to form suspended in a molten liquid phase which contains more silica than did the original melt. On cooling to a temperature of 1170°C. however, a transition point is reached at which the mineral leucite changes to orthoclase by abstracting silica from the residual molten liquid in which the crystals are growing. With slow cooling, as in the deep-seated plutonic rocks, there is time for the complete conversion of leucite to orthoclose so that these rocks do not contain leucite. In the case of lavas however, rapid cooling takes place and the rock may solidify before the conversion to orthoclase can take place, so that leucite is restricted to lavas extruded on the surface which solidified at high temperatures.

Orthoclase itself occurs in two forms. Sanidine, the high temperature glassy variety, passes into orthoclase at a temperature of about 900°C. Sanidine is restricted to lavas such as rhyolites and trachytes, and is not found in the plutonic rocks. These lavas therefore solidified above 900°C., whilst deep-seated rocks solidified below this temperature.

The evidence of the minerals contained in igneous rocks therefore shows that the deep-seated plutonic rocks solidified at temperatures between about 575°C. and 800°C. However, the lavas erupted on the surface solidified between temperatures of about 800°C. and 1000°C. or more.

Effect on the enclosing rocks of heat from an intrusive rock

When very large masses of molten igneous rocks are intruded into sediments, the enclosing sediments are heated up for long periods before the magma and the heated enclosing rocks finally cool down. Mineralogical changes take place in the enclosing sediments, depending on the amount of heat developed and the chemical composition of the enclosing rocks. If these rocks are shales, aluminium silicates are usually formed, the most interesting ones from the temperature point of view being the series chiastolite, andalusite, and sillimanite. These three minerals are of exactly the same chemical composition (Al_2O_3 SiO_2), the particular mineral formed, depending on the amount of heat developed (see Fig. 2). At a distance from the intrusion where the heat would be less intense, the mineral chiastolite forms. Nearer still, with higher temperature, andalusite forms, whilst at the actual contact with the igneous rock needle-shaped crystals of sillimanite are developed.

These changes can be studied in the shales surrounding the Skiddaw Granite in Cumberland.

Andalusite has artificially been changed to sillimanite by heating to a temperature of 1320° to 1380°C., so that the temperature of the molten igneous rock at the time of its intrusion and at its contact with the enclosing rock was of this order. The temperature of solidification of the magma was of course much lower than this, as has been indicated previously.

Where igneous magmas were intruded into limestones, the mineral wollastonite (calcium silicate) is commonly developed in the limestone as a result of the heat given off by the magma. This mineral can only be formed at temperatures below 1180°C. Above this temperature a modification of the same chemical composition is developed. The presence of wollastonite in a metamorphised limestone is therefore proof that as a result of the heat given off by the neighbouring intrusion the rock re-crystallised at or below 1180°C. The high temperature form of wollastonite is occasionally found in fragments of limestone caught up within the magma itself and therefore subjected to its full heat.

This again points to the fact that plutonic rocks have a temperature of about 1300°C. or over at the time of their injection into the enclosing rocks.

It appears, then, that plutonic magmas were intruded at a temperature between about 1100°C. and 1300°C. and that the temperature dropped to about 600° to 800°C. before these rocks finally solidified.

[Continued on p. 352

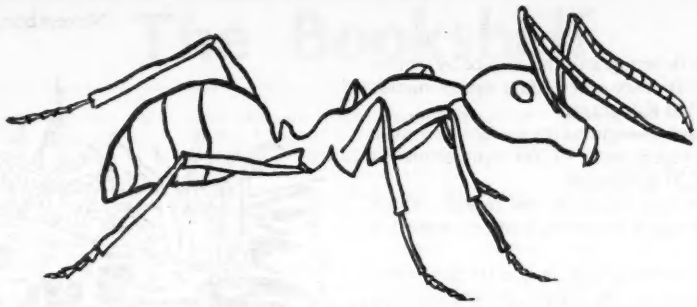

FIG. 1.—The common large black ant, *Formica fusca*, *L.*

Economic Ants

B. D. WRAGGE MORLEY, B.A., F.L.S.

FROM east to west and north to south, wherever man travels until he reaches the latitudes of snow and ice, he will find "the hurrying pismire". Wherever he is he need never search far, except in winter, before he finds some of these six-legged Lilliputians. Yet does he ever stop to consider the significance of their presence?

Man is the dominant animal of the present-day world, but except where he has disputed their possession the ants have ruled an equally world-wide, if more truly terrestrial world, for a greater space of time than man has existed. Larger animals may trample over their domain and temporarily dispute their power, but not for long; and the immediate surface of the earth and the six inches below it go back to their historic suzerains, the ants.

This domination is reflected in four things:

(1) The widespread geographical distribution of the ants, equalled by no other animal except man and his parasites.

(2) The large number of guests (myrmecophiles) found in ants' nests: over 1,200 other species of insects have already been described as being found in ants' nests throughout the world, and large numbers of new "guests" are being described each year. The ants defend many of their guests, even parasites, with great tenacity.

(3) The large number of insects destroyed by ants:—a single colony of our common Wood ant, *Formica rufa*, L. may destroy, according to Stumper and Donisthorpe, between 50,000 and 100,000 insects each day; while Forel says that a single nest of another Wood ant, *Formica pratensis*, Retz, will destroy 40,000 insects a day. Hill states that 80% of the nests of the termites *Drepanotermes Silvestrii* and *Hamitermes perplexus* in South Queensland, Australia, are occupied by the Dolichoderine ant *Iridomyrmex sanguineus*, F.

(4) The chief enemy of an ant is another ant: an analogous condition is only found in the case of man.

Cannot the myrmecologist therefore be excused his smiling when he is asked, as he usually is in all innocence, "Why do people study ants? What on earth is the use of it?"

Darwin justified for all time the usefulness of the common earthworm in temperate climes in his oft-quoted work on *Vegetable Mould and Earthworms*. Yet how many people realise that in South America a similar function—aerating the soil and bringing new earth to the surface—is even more efficiently performed by the ants? Banner in his Smithsonian Report for 1911 (pp. 303-33) gives comparative figures for earth brought to the surface by worms in England (based on Darwin) and by ants in Brazil.

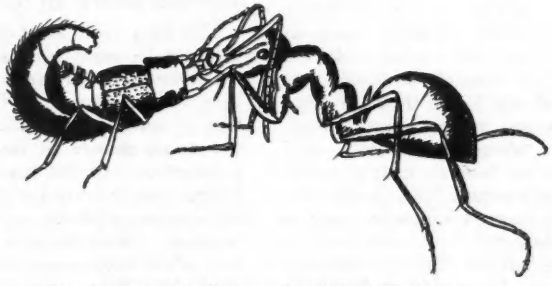

FIG. 2.—An ant feeding one of its "guests". *Atemeles pratensoides*, Wasm. being fed by *Formica pratensis*, Retz (after Wasmann).

Total weight of earth brought to the surface by worms in England in 100 years over 10,000 square metres .....2,598,500 Kilograms.

Total weight of earth brought to the surface by ants in Brazil in 100 years over 10,000 square metres .....3,226,250 Kilograms.

Even in England their importance in this respect cannot be insignificant, and in Brazil, where there are no worms, it is vital.

Plagues of ants sometimes occur in the tropics, apart from the usual ravages of the Siafu or Driver Ants (*Dorylinae*). Schomburgk in his *History of Barbados* (1848) records how in 1760 "it was deliberated whether that island formerly so flourishing should not be deserted" on this account. The same ants visited Martinique in 1763 and Granada in 1770. The damage done by these ants appears to have been indirect, being due to the aphides or other root-feeding insects kept by the ants for their sweet excreta, damaging the roots of the sugar canes.

In Granada "their numbers were so immense that they covered the roads for many miles together; and so crowded were they in many places, that the impressions made by the feet of the horses which travelled over them would remain visible for a moment or two, until they were filled up by the surrounding swarms." The island was eventually saved by a tornado of great violence, after all the attempts at the destruction of the ants had been in vain, despite the stimulus of a reward of £20,000 offered by the Government.

FIG. 3.—Cross-section of an "ant hill" to show excavations and the manner in which the soil is brought up from below to form the hillock, or be spread on the surface of the ground. In South America the hillocks and the amount of soil brought up in this manner reach vast proportions.

Solomon may have done well to bid the sluggard study the ways of the ant, but if man regards the ants merely as some sort of philosophical or sociological *argumentum* then he is neglecting the very real economic importance of this group of insects.

VITAMINS—*Continued from p. 345*

beach. As in the days before vitamins were known, we are still dependent on protein, fat, carbohydrate, water, and minerals for the bulk of our diet, for the energy and body-building materials. The vitamins are indispensable accessories, but we are learning that there are other essentials. A number of aminoacids (breakdown products of proteins), are recognised as necessary constitutents of normal food supplies. Linoleic acid is now believed to be an essential constituent of our fatty intake. Are there likely to be any unknown vitamins? Quite possibly. Nutritional knowledge is increasing rapidly. Developments must be expected in the field of mineral requirements. Already "trace elements" are beginning to be recognised. These are elements which are required by the vegetable or animal for normal existence. A lack of iodine, for example, leads to cretinism; while a killing disease which cost sheep farmers large sums of money was found to be curable by administering very small quantities of cobalt to the animals. A number of unexpected elements have been detected in odd parts of the body, and some of these may well prove to be essential trace elements.

GEOLOGICAL THERMOMETERS—*Continued from p. 350*

Mineral Veins

The mineral contained in mineral veins is usually considered to have been obtained ultimately from an igneous rock. On solidification of the molten rock, the fluxes and gases containing the mineral substances now found in veins were expelled and found their way into fissures and occasionally formed mineral veins. Naturally, the temperature was falling continuously until finally it became low enough for minerals such as quartz calcite, etc., to precipitate from these ore bearing solutions. The quartz formed in these veins is α quartz which is formed at temperatures below 575°C. In one case in Durham, a vein containing barytes (Barium sulphate) crosses a coal seam. The seam however is unaltered, so that the temperature of deposition of the barytes in the vein must have been below that at which coal changes into coke.

Temperature of formation of Salt Beds

Salt beds such as those found in the Stassfurt salt fields of Germany also offer interesting details of their temperatures of formation. These potash and other salts were formed in large lake basins as a result of the evaporation of water over considerable geological periods. With the desert climate of the time there was considerable evaporation and the later salts are formed at a higher temperature than the early ones. Thus glauberite (sodium and calcium sulphate) required a temperature above 10°C. to form. Whilst the salts keiserite (magnesium sulphate) and sylvite (potassium chloride), which was formed at a much later time, required a temperature of over 72°C. to be deposited.

The Bookshelf

Mathematician's Delight. By W. W. Sawyer. (Pelican Books, 1943; pp. 200; 9d.)

PROBABLY no subject has suffered more than mathematics from mechanical teaching. Mathematics, as it is usually taught, begins with a rigmarole of rule learning and passes on to the deadly discipline of formal proof. Few survive such teaching. Those who do survive, do so because they discover a real delight in mathematics which has little to do with its formal aspects. The research worker knows that he makes his advances first by methods which flagrantly break all the rules of formal mathematics and that afterwards he consolidates his position by the use of formal methods. And he knows that it is the first informal break-through that provides the joy, the formalisation being a necessary but somewhat dull task that follows. Yet the conventions of formal proof press so heavily on the teaching side that but a very few ever succeed in conveying to the non-mathematician, or to the schoolboy or student who is a potential mathematician, even an inkling of the great joy of mathematical discovery.

Mr. Sawyer is one of the few. His book demonstrates how the delights of original discovery can be introduced into the learning of mathematics from the very beginning. His recipe could be summed up in one word, "Experiment!" You can experiment with real objects and real problems, or you can experiment with some mathematics that you already know. You will find certain relations that appear always to be true. To decide whether or not they are always true is the province of formal mathematics. But that can be taken at a later stage. The important thing is first to discover the relations and to appreciate their significance; and that can only be done by experiment. (If any reader wonders how one can experiment with mathematics, let him read this book and see.)

The reviewer, a professional mathematician, is not ashamed to admit that he finished this book with a clearer understanding of some branches of the subject. The lay reader should benefit even more.

S.L.

Physics and Philosophy. Sir James Jeans, (C.U.P., 1942; pp. viii + 222; 8s. 6d.)

SIR JAMES JEAN'S book, first published in 1942, has recently been reprinted, an indication of the great interest which it aroused, since publication even on a single occasion is difficult enough to achieve in these days of severe paper restrictions. However, there can be little doubt that Sir James will be numbered among surviving authors for a very long time, even if the restrictions become much more severe still. His book consists of a straightforward exposition of philosophical theories and of those parts of modern physical theory which have been chiefly responsible for putting the idealist cat among the materialist pigeons. If little comment is possible on this section of the work, it is because the superbly clear literary style of the author has long since rendered it unnecessary.

The chapters which will be of the greatest interest are those in which Sir James expounds his own views as to how the real or apparent antagonism between the two schools of philosophy can be resolved. These views are set out in his discussion of the philosophical systems of Kant and Eddington, and in Chapter VII, which is entitled "Some Problems of Philosophy". One discussion of special interest is that entitled "The Simplicity Postulate", in which the author reviews the present status of the principle, originally based on Occam's Razor, that if two scientific theories are possible, the simpler should be chosen as a working hypothesis.

It may be a disappointment to some readers, and indeed Sir James admits this himself, that no very precise conclusions can be drawn from the whole discussion. He remarks in his final paragraph "Just because of this, we cannot state any positive conclusions of any kind, as for instance that materialism is dead, or that a deterministic interpretation of the world is obsolete, but we can say that determinism and freedom, matter and materialism need to be redefined in the light of our new scientific knowledge."

Such indefiniteness may give a feeling of anti-climax, but even such a negative conclusion is of value since it will perhaps give pause to those who wish to embrace the conclusion that all the philosophical problems of modern physics have been finally settled. It needs both courage and mental integrity to make a positive assertion of ignorance, and Sir James' high reputation among his fellow scientists will be the more enhanced for that. However, even though the conclusion may be indefinite, the reader can be assured that on arrival at page 217 he will still be asking for more, and will have realised the truth of R. L. Stevenson's aphorism, "To travel hopefully is a better thing than to arrive." D.S.E.

Weather Study. David Brunt, F.R.S., (Nelson, 1942; pp. xii + 216; 5s.)

THE reader of this introductory text-book will soon realise why it has been reprinted twice since it was first published in 1942. Its lucid and accurate style mirror the author's own attractive personality. It is complete and thorough, but never stodgy; straightforward but patient over difficulties. It is a fine example of what a text-book ought to be.

The contents show how much ground has been covered, and how well the book meets the requirements of the Air Force Cadets for whom it is principally intended. The exposition starts with an elementary discussion of instruments and meteorological measurements, and goes on to a brief discussion of the diurnal and seasonal variations of meteorological conditions, and the influence of geographical factors on them.

A sound theoretical background is built up in the next four chapters by the analysis of observations and of meteorological phenomena. The student who follows through the discussion of atmospheric equilibria, the upper air, the influence of radiation and of water vapour will acquire not only a sound knowledge of meteorology, but a fair grounding in elementary applications of physical principles as well.

Further chapters deal with clouds and their classification, fog and mist, and the important subject of the plotting of observations. From this follows logically a preliminary study of large scale meteorological phenomena such as depressions and anti-cyclones, and of special topics such as thunderstorms and revolving storms. Especially in his discussion of the movement of air masses and the formation of cold and warm fronts does Professor Brunt prove himself a past master in the art of exposition. For Air Cadets unaccustomed to abstract thinking there are few more difficult subjects to explain than a three-dimensional phenomenon. Professor Brunt recognises the difficulties and has overcome them triumphantly.

He is to be congratulated on making yet another addition to his long record of service to the science of meteorology by putting a perfectly fashioned weapon in the hands of those who will know how best to use it. D.S.E.

An Easy Outline of Astronomy. M. Davidson, D.Sc., F.R.A.S. (Watts & Co., Ltd., 1943; pp. iv + 108 + 11 illustrations; 2s. 6d.).

PROBABLY more popular books are being published on astronomy than on any other science. Undoubtedly the black-out has stimulated interest in the subject, but it may be wondered whether the publications are not a good deal more numerous than is warranted by its intrinsic importance. However, although many of the astronomical works are of uneven quality, it is impossible to have too many good books on popular science whatever their subject-matter.

Dr. Davidson's book is definitely a good one. It has an extremely business-like air about it, and contains an extraordinary amount of solid information served up in a very digestible form. A feature of special interest is the appendix on astrology, in publishing which Dr. Davidson has rendered a considerable service to the cause of popular enlightenment. His aim is to show that it is untenable on the synonymous grounds of science and common sense. While he does not enlarge on the social and political implications of astrology, it is clear that he is aware of the very real danger which they present. The same spirit of imaginative realism is evident throughout the book, which gains tremendously in value from the author's patient understanding of the interests and difficulties of his readers. D.S.E.

Far and Near

Lord McGowan on Research

INTERESTING observations about scientific research were made by Lord McGowan, chairman of I.C.I. Ltd., when he addressed a joint meeting of the Chemical Engineering Group of the Institution of Chemical Engineers and the Society of Chemical Industry in London last month. The title of his talk was "The Future of the Chemical Industry", but many of his remarks were applicable to other branches of industry. He said that while it was a mistake to saddle the universities with research which properly belonged to industry it was equally wrong to set up any barrier between university and industry. The more each knew of the other, the better for both. "It would be to the good of all", said Lord McGowan, "if from time to time university workers were hauled gently to the ground in order to observe the functioning of life at the lower levels : and for industrial workers to be hoisted equally gently so that they may be given a clearer view of the stars of the scientific firmament."

Industry's responsibility in research was to investigate problems with which industry was concerned, and its efforts were mainly centred in the research associations and the larger industrial concerns. The research needs of chemical manufacturers were too many and varied to be covered by any one chemical research association. What was needed was a far greater measure of research co-operation between firms. There was also the problem of the small firm whose resources were likely to be insufficient to permit it to undertake adequate research. Though such firms could not look for help to a research organisation of their own, there was room for some organisation to help them. In this connection Lord McGowan noted the work of the Mellon Institute in the U.S.A. In addition to fundamental and industrial research there was a vast job of work which could and must be done under Government auspices. This included problems of national concern as for instance those connected with coal ; the responsibility for organising a research programme of such magnitude clearly rested with the Government.

Lord McGowan also commented upon the importance to the chemical industry of patents and the manner in which they were exploited. There appeared to be a feeling, he said, that because companies and individuals could at present obtain exclusive licences for a particular process they were in a position either to sell the product at a higher price or suppress it altogether if it threatened processes in which they were already interested. It had been suggested that the system of exclusive licences should be abolished and superseded by one of non-exclusive licences obtainable as a right by all wishing to secure them. The adoption of such a proposal would not have the effect intended. First, the grant of non-exclusive licences only would lead direct to unrestricted competition and to manufacture in small units and at high costs. Secondly, it would lead to a great increase in the operation of inventions as secret processes—with the most unfortunate effect. In any event these matters were taken care of by the existing Patents Act itself which would be obvious to anyone who took the trouble to read it.

Research by the Ton

A PROGRAMME of research and education in matters affecting the growing of sugar beet in Britain came into operation last April. A recent Statutory Rule and Order, made by the Minister of Agriculture and the Secretary of State for Scotland, gives details of the financing of this research scheme, on which about £15,000 has so far been spent. The money was raised by a levy of a halfpenny a ton on home-grown beet sold by the growers, and of a further halfpenny paid by the British Sugar Corporation, Ltd., for every ton delivered to that organisation. Research stations which have undertaken investigations under the project include Rothamsted, the Cambridge Institute of Agricultural Botany, the Midland Agricultural College, Cambridge School of Agriculture and Plant Breeding Institute, Norfolk Agricultural Station and the National Institute of Agricultural Engineering.

Farmers and Research

To form a connecting link between the agricultural scientist and engineer, and the practical farmer, the National Farmers Union has set up a Technical Development Research and Education Committee of twelve members, seven appointed by the N.F.U. Council, four from county branch nominees and one co-opted. Chairman is Mr. R. A. Ward of West Sussex.

Sounding for Seaweed

To detect beds of the seaweeds required for producing agar-agar and other materials, an improved echo-sounding apparatus similar to that used for detecting submarines has been put into practice in America. It is understood that a similar technique was used in this country when a survey of our shores was made in order to discover likely sources of agar-agar.

A recent report of the Ministry of Health states that after the supplies of agar-agar from Japan ceased the coasts of Great Britain were searched for a seaweed which would yield a preparation having all the properties required by the bacteriologist. The search was successful and extensive trials were made in order to find the most effective method of extraction. The first batches produced on a commercial scale have been tested and have proved suitable for all bacteriological media. Collection of the particular species of seaweeds is being organised and controlled so that the beds may not be spoilt by over-gathering.

Personal Notes

DR. W. M. TATTERSALL, Professor of Zoology since 1922 and deputy principal of University College, Cardiff, died on October 5th at the age of 60. During his association with the Irish Department of Fisheries, with which he served as an assistant naturalist, he gained much knowledge of marine biology. He was a zoologist of wide interests, so that although he specialised in certain neglected groups of the Crustacea he found time to discover, for instance, the egg capsules of the common periwinkle and to describe the life-history of that animal. A leading authority on crustaceans, he had almost completed before his death a monograph on the British species of the Mysidacea (the Opossum Shrimps).

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Two trade union leaders were last month appointed to the advisory council of the Department of Scientific and Industrial Research. One of them was MR. J. BENSTEAD, general secretary of the National Union of Railwaymen, and the other MR. E. THORNTON, secretary of the United Textile Factory Workers' Association. SIR JOHN GREENLY has retired from the council on the completion of his term of office.

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As a memorial to the late PROFESSOR WARRINGTON YORKE, the great authority on tropical diseases who died recently, £500 has been placed in the trust of the Council of the Liverpool School of Tropical Medicine by Sir Robert Rankin, M.P. The Council has decided that the memorial should take the form of a medal, to be awarded twice yearly, on the result of the examinations for the Diploma in Tropical Hygiene. The medal is being designed by the sculptor of Liverpool Cathedral, Mr. E. Carter Preston, who was also responsible for the design of the D.F.C. and the D.F.M. of the Royal Air Force.

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Correspondents in Stockholm report that NIELS BOHR, world-famous physicist and 1922 Nobel Prizewinner, is among the Danish refugees who have escaped to Sweden. Born at Copenhagen, Bohr studied at his native university before proceeding to Cambridge where he studied under Sir J. J. Thomson. In 1916 he was appointed professor of theoretical physics at Copenhagen University, and later became head of a newly-established institute for theoretical physics research.

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PROFESSOR ARTHUR AVERY READ, Emeritus Professor of Metallurgy, University College of South Wales and Monmouthshire, Cardiff, died suddenly at Bournemouth on September 24, aged 75. He went to Cardiff in 1894 as the first lecturer in the new department of metallurgy and started the work of his department in two basement rooms, with a grant

of £100. A few months before his retirement in 1933 he saw his building scheme completed, thanks to the generosity of the Monmouthshire and South Wales Coalowners' Association.

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A new departure in business policy was marked last month with the appointment of Professor David Mitrany to the board of Lever Bros. & Unilever, Ltd., as adviser on social and political questions. Professor Mitrany received his academic training in England and is the holder of a research chair in America.

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MR. W. H. COLLINS, chairman of Fortnum and Mason and of Cerebos Ltd., has given £100,000 to endow the Department of Pathology and institute a Chair of Human and Comparative Pathology at the Royal College of Surgeons of England. In his will he has provided for a bequest of a similar amount to endow the Department of Anatomy and institute a Chair of Human and Comparative Anatomy.

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Among the candidates down for election at the new session of the Academy of Sciences of the U.S.S.R. are four physicists who have worked in the Cavendish Laboratory, Cambridge. They are DRS. KHARKOV, KIRILL, SINELNIKOV and LEIPUNSKY.

A National Health Service?

DR. EDITH SUMMERSKILL, M.P., speaking at Norwich on the Public Health Service, said that a very superficial examination of the present system will reveal that it is wasteful, limited in scope and approaching the disease from the curative rather than the preventive angle. The service we need must be planned, preventive as well as curative, open to all as well as being equitable for the medical profession. It should be directed from the centre by the Ministry of Health subject to control by Parliament. The country would be divided into regions each with a separate elected regional authority. Each region would have divisional hospitals of about 1000 beds for surgical, medical and maternity cases, each serving a unit of population of about 100,000. Attached to each would be a regional health centre where patients needing treatment which could not be given at the local health centres could attend. Local health centres could serve those people who needed advice from a general practitioner. The time has arrived for the private profit motive to be entirely removed from the practice of medicine. Co-operation between doctors must replace the old discreditable competition. In these days when medical science is making rapid strides it is impossible for each general practitioner to provide the necessary equipment and facilities for the adequate treatment of disease.

Health in War

ONE of the most interesting passages in the Summary Report of the Ministry of Health for the year ended March 31, 1943, (H.M.S.O., 1s.) concerns the Emergency Public Health Laboratory Service. Before the war, the report states, the Ministry maintained in London a small but highly efficient laboratory to assist local medical officers of health in investigating outbreaks of epidemic disease. The long-appreciated need for a considerable expansion of this service has now been largely met by the establishment of the Emergency Public Health Laboratory Service. Numerous laboratories have been provided at key points throughout England and Wales, and it is now possible for medical officers of health, when faced with an outbreak of infectious disease, to call upon the nearest emergency laboratory for help, both in the field and in the laboratory. During 1942 each of the constituent laboratories of this emergency service investigated several outbreaks which would not, and for all practical purposes could not, have been investigated had not the laboratory staff been ready on the spot at the time. Such outbreaks included dysentery in residential nurseries, scarlet fever in evacuated schools, enteric fever at an aerodrome and food poisoning in canteens.

The report expresses the view that this combination of laboratory and field work may well become a permanent part of the national armament against infectious disease, as in the past many outbreaks of infectious disease have not been investigated, and often their real nature has been overlooked because the necessary facilities were not available.

The origin of the country-wide survey which is being made to check the haemoglobin content of human blood is given in this report. Dr. V. P. Sydenstricker, who came to England under the auspices of the International Health Division of the Rockefeller Foundation, suggested that an inquiry should be made into the cause of the pallor prevalent among women of child-bearing age. As other evidence published by clinicians suggested a fall in the haemoglobin content of the blood (which the Blood Transfusion Centres were unable to confirm or deny) the Medical Research Council set up a special committee to conduct a nation-wide survey. This survey will determine the haemoglobin content of the blood of at least 10,000 people of all ages, both sexes and many occupations in town and country.

Other special surveys have been initiated by the M.R.C. One showed that the vitamin C content of human milk was greater in 1942 than in 1941, as was the vitamin B content. Another M.R.C. investigation suggests that certain diseased conditions of the gums—popularly known "trench mouth"—are caused by infection rather than dietary deficiency.

A disease which is spreading all over Europe and the Mediterranean area is epidemic jaundice. The report states that this disease is believed to be due to an ultra-microscopic virus; the incubation period is long (the average being 28 days), so that it is only when a group is kept together for a period that cases accumulate and an outbreak is recognised. Lack of knowledge about its cause and prevention led the Ministry in consultation with the War Office to ask the M.R.C. for a special investigation, and a committee for this purpose has been set up with Professor L. J. Witts as chairman. Laboratories have been established in the Pathology Department of Cambridge University, staffed by a team of five whole-time workers led by Dr. F. O. MacCallum of the Wellcome Research Institution. Combined clinical, pathological and epidemiological research will be conducted on civil and military cases occurring with the Cambridge Civil Defence Region.

Microchemical Analysis

AT a joint meeting held last month in the Department of Applied Science, St. George's Square, Sheffield, between the Microchemical Club, the South Yorkshire Section of the Royal Institute of Chemistry and the Sheffield Metallurgical Association, an interesting collection of apparatus representing a wide range of microchemical activities was on view.

Among many interesting papers read at the meeting, Mr. Whalley dealt in some detail with the development of the methods for the analysis of steels and aluminium alloys. Dr. Wyatt described a few of the many types of apparatus now available for the microchemist who wishes to carry out volumentric analysis. The minimum of apparatus which is necessary for polarography was detailed by Mr. Stock. A comparatively new development of polarographic technique is the employment of amperometric titrations to carry out analyses. Mercury oxycyanide, explained Mr. Ingram, has shown itself to have a variety of uses, and it is now possible to apply it to the estimation of halogen, sulphur, and methoxy and ethoxy groups. Mr. Price described in some detail the method of handling the apparatus referred to above for the analysis of minute bubbles of gas. The teaching of microchemistry in this country is not nearly as widespread or as generally available as is possible and desirable, claimed Dr. Wilson. He outlined a specimen course which took up about six weeks continuous work, and which should, in his opinion be available to any chemist. In addition, refresher courses of a more specialised type should be accessible to enable chemists to keep up with the most recent advances in any branch of the subject.

First British "Dried Meat" Plant

A PILOT plant for the manufacture of dried meat—the first of its kind in the United Kingdom—has just been brought into operation in Northern Ireland.

According to *Electrical Communication*, the industrial electronics division of the Federal Telephone and Radio Corporation of Newark, New Jersey, in co-operation with the Office of the Quartermaster-General of the U.S. Army has developed a process of dehydrating food by means of radio-frequency energy. The process

makes possible the removal of 99% of the moisture content from a compressed vegetable block, for instance.

Quick-freeze for Fruit

FOR a long time fruit has been kept as pulp prior to conversion into jam, sulphite being used as the preservative. Last month the director of the British Association of Research for the Confectionery and Jam Trades stated that freezing may take the place of pulping for preserving fruit for jam-making. Our London correspondent understands that he was referring to quick-freezing, the process whereby the fruit is rapidly frozen to a low temperature, so preventing the formation of large ice crystals which are liable to cause rapid deterioration of the fruit tissues to occur on thawing. After a foodstuff is quick-frozen it can be stored in ordinary refrigerators for an indefinite period. Our correspondent finds, moreover, that quick freeze machines have already been at work on fruit farms in Britain during the war, preserving fruit that was afterwards converted into jam. The process has long been in favour in the U.S.A.

The B.A. and Atrocities

THE Council of the British Association has placed on record its deep concern at the atrocities committed by the enemy in occupied countries, especially in regard to the destruction of buildings and objects conductive to the advancement of human culture. The activities of the Association throughout the war have been concerned primarily with calling attention to the essential applications of science in post-war reconstruction.

Wireless-controlled Aircraft

IT was reported recently from Malmoe, Sweden, that a German aircraft which crashed on the Danish island of Bornholm, in the Baltic, was of a wireless-controlled type, for which no crew is needed. There is nothing new in the principle, for Britain has for a number of years employed what is known as the wireless-controlled "Queen Bee" for target practice for gunners. It would appear, however, that the Germans have developed the idea for operational purposes. The "Queen Bee", when details were released concerning it, had definite limitations of range, though it may since have been developed.

Animal Diseases cost £30,600,000 a Year

IN his presidential address to the National Veterinary Medical Association DR. W. R. WOOLDRIDGE declared that the profession could accomplish much more for the prosperity of agriculture and the healthier feeding of the people. The veterinary surgeons should assist farmers to ensure that all foodstuffs of animal origin, such as milk, meat and eggs, were safe and of the highest quality. They should see that the quality of other animal products, such as medicinal substances, wool, furs, leather, sausage skins, and surgical gut, was not impaired through ill-health during the life of the animal. A huge industry with an annual value of some £200,000,000 had been built up on animals and their products. Many diseases had been eradicated. Nevertheless, the more insidious diseases had become established at a high level of incidence. Losses were now costing more than £30,000,000 a year. To-day, with fewer than 3,000 veterinary surgeons active in Britain, there were 2,500,000 dairy cattle under no regular veterinary supervision. This indicated the vast field awaiting veterinary cultivation.

The Duke of Norfolk, Joint Parliamentary Secretary to the Ministry of Agriculture, said the smallness of the veterinary profession was probably the reason why we still had far too much disease among our animals, and if we could by the Veterinary Educational Trust produce some form of scholarships, post graduate courses or refresher courses, we would provide education beneficial to the country which would appeal to the right type of men to enter the profession.

Substitute for Sponge Rubber

AMERICAN reports indicate that the Bauer and Black Research Laboratories have produced a substitute for sponge rubber from linoleic acid, a derivative of vegetable oils. It is claimed that this product can be made in various thicknesses and densities, and that it can be vulcanized directly onto many metals and plastics.

Contrary to natural sponge rubber, it appears that this substitute's flex-cracking resistance improves at lower temperatures.

Rubber from Golden Rod

THE American Bureau of Plant Industry, Soils and Agricultural Engineering have planted golden rod in plots ranging from 2 to 10 acres in extent in as widely separated parts of the U.S.A. as South Carolina Alabama, Mississippi, Louisiana, Texas and California. A larger experiment of some 550 acres growing various selected strains of this plant is being carried out by the Forest Service in Georgia.

It is the leaves of golden rod that are used in the processing for rubber. They can be processed immediately upon gathering or stored for future use. Upon the result of this year's experimental processing in the Government's Southern Regional Research Laboratory at New Orleans will depend what increase in acreage is planted for next year's crop.

Linnean Society

AMONG the interesting papers in the current *Proceedings* of the Linnean Society of London is an account by Dr. B. P. Uvarov of some of the Orthoptera material collected on the Armstrong College Expedition to the Oasis of Siwa in Egypt in 1935. Some 644 specimens belonging to 35 species have been worked out in detail, and they represent a solid basis for a study of such a limited fauna as that to be found in the Siwa Oasis.

In the same issue, C. G. Hansford, senior plant pathologist in the Uganda Department of Agriculture, continues his contribution to the study of the fungi of Uganda.

U.S. De-Icing System

MR. T. GIRDLER, chairman of the board of the Consolidated Vultee Aircraft Corporation of San Diego, California, announced recently the development of a system of de-icing for aircraft which he claimed is so effective that it is possible to maintain a constant temperature of 60 deg. F. at the leading edge of the wing even when flying in air temperatures of 40 deg. below zero.

The system utilizes the basically simple idea of circulating exhaust heat from the engines through ducts to de-ice the wings and tail surfaces and de-frost the pilot's screen. Mr. Girdler claims that this system allows no ice to form while the machine is in flight; that it functions as soon as the motors are started, thus melting any ice which may have formed while the aircraft is still on the ground; and that no loss of efficiency is experienced, the system working effectively at high and low speeds.

This de-icing system, Mr. Girdler disclosed, has been installed in the Consolidated Catalina, and will be fitted to other long-range types of aircraft.

New Acoustic Stethoscope

THE Radio Corporation of America laboratories have perfected a new acoustic stethoscope which will record sounds inside the human body ranging from 40 to 4000 cycles. The old stethoscopes range was between 200 and 1500 cycles. Dr. H. F. Olson says that the new stethoscope will couple the ears of the doctor much more closely to the human body through the employment of a reversed taper tube, which greatly improves the matching of the acoustic elements. By the use of a filter employed in the R.C.A. instrument, the turning of a knob limits the range at will.

Research in Housing

IN the B.B.C. talk "The Science of Building" recently broadcast by Sir Edward Appleton and Sir George Burt, the Secretary of the D.S.I.R. gave the interesting news that his department was working on problems dealing with improved housing. "They are dealing for example," he said, "with such matters as heating, ventilation, plumbing, artificial lighting, day-lighting, noise reduction and so on. In their work they are carrying out accurate experiments on bricks, on walls and rooms, and even on specially built houses. In this way they are gaining knowledge and finding ways of improving the quality and comfort of houses, without having to rely on guesswork."

In the U.S.A. scientific attention is also being directed onto the post-war home. E. V. Alvord, head of the Speciality Chemical Section of the American Du Pont Co's. Grasselli Chemicals Dept., says that the post-war American house will almost certainly be made of standardised, mass-produced parts, assembled to a plan determined by architect and owner. It is thought that plywood adhesives recently perfected for the aircraft industry will be available to the builder after the war. Air-conditioning of houses will also play a big part as well as an increase in refrigeration.

Printed and Published by Jarrold & Sons, Ltd., The Empire Press, Norwich

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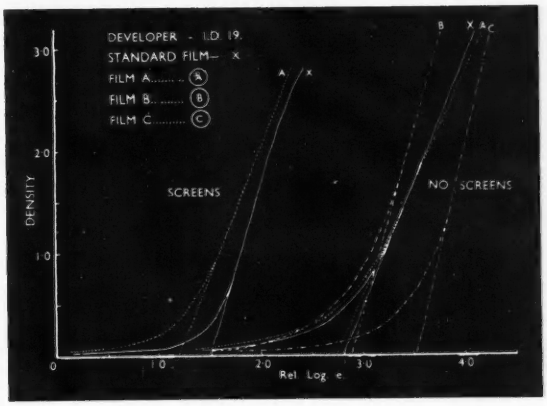

THE need of Industrial Radiography to-day is for a range of sensitised materials varying in their characteristics according to the work to be done. Ilford Limited have met this need with 3 distinct types of X-ray films which fully cover every requirement. A description of these films is given below.

The diagram above shows the characteristic curves of these films in comparison with Ilford Standard X-ray film used in medical radiography.

ILFORD Industrial X-ray Film A

An exceptionally fast screen film which can also be used without screens or with metal screens—a truly "general purpose" film, suitable for the radiography of all structures from the lightest to the heaviest whether with X-rays or Gamma rays.

ILFORD Industrial X-ray Film B

A fast non-screen film, insensitive to the fluorescence of salt screens, but usable with metal screens—an improvement on the general purpose film A for all exposures which either must be made without salt screens for the sake of definition, or which can economically, and for preference be made without salt screens.

ILFORD Industrial X-ray Film C

A slow, fine grain, high contrast film for the detection of the finest detail in light structures, or in thin sections of heavier materials, which can be easily penetrated

ILFORD
INDUSTRIAL X-RAY FILMS

The following Ilford booklets contain full information of all Ilford Industrial X-ray materials and will prove useful to Industrial Radiographers

"Ilford Products for Industrial Applications of X-rays and Gamma Rays."

"Photography as an Aid to Scientific Work."

ILFORD LIMITED, ILFORD, LONDON

GOLD IN BRITAIN

BRITAIN is not a recognised gold bearing country, but there is gold in Britain. The Romans knew this, and mined it, notably in the valley of the Cothi in Carmarthenshire, where they had a flourishing settlement. The British Empire on the other hand is the greatest producer of gold in the world. Gold mining is no longer an affair of pick and shovel and washing-pan, but a highly developed industry in which chemicals are used extensively. Indeed, gold production on the scale carried on to-day is only possible as a result of British chemical research. In 1890 the position of the great South African industry was critical. The extraction of gold from the Rand reef was becoming impossible, and it was actually thought that the end of the industry was in sight. In the cellar of a Glasgow tenement a young chemist named MacArthur was working on a process of recovery of gold from ores by means of cyanide. MacArthur had noticed that the method then in use for "toning" photographs used a solution of gold, and he was able to prove that a weak solution of cyanide would dissolve the gold from the ores, leaving the base metals behind. He was sent to demonstrate his method to the Rand mine-owners. For two days and nights he worked on the problem at the Salisbury mine at Johannesburg. Late on the third day he produced a small ingot of gold. It showed 98 per cent. extraction ! The Rand gold mining industry was saved. To-day the cyanide method of gold extraction is used in gold mines all over the world. Even gold depends for its production upon the work of the British chemist.

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Imperial Chemical Industries Limited, London, S.W.1

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